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Undergraduates are expected to be familiar with the contents of this publication and are personally responsible for complying with all rules and regulations of the University. Matriculating students are solely responsible for completing all degree requirements.

Policy statements and fee schedules as published in this *Bulletin of Undergraduate Studies* reflect information which was current at the beginning of the academic year 1986-1987. Such statements and schedules are not intended to be and should not be relied upon as statements of University contractual undertakings. Although the University provides notice concerning changes of policy and fee schedules as is reasonably practicable under the circumstances, it reserves the right in its sole judgment to implement new rules and regulations and to make changes of any nature in its program, calendar, procedures and standards, degree requirements, and academic schedule—including, without limitation, changes in course content and class schedules. The office of the registrar publishes current University academic policies in the semester class schedule. Special announcements also are periodically released by departments, colleges, and the University and, when feasible, these also are published in the *Connector*, the student newspaper. Administrative policies of a system-wide nature (e.g., admissions policies, tuition, and fees) are subject to change by the Massachusetts Board of Regents of Higher Education without advance notice.

When changes are necessary, the University of Lowell exerts reasonable efforts to provide comparable or substantially equivalent instructional services and facilities for those originally designated. However, it assumes no liability for failure to deliver or for delay in delivering such services (including those in support of academic functions or student life) when the causes for such failure or delay are beyond the reasonable control of the University—which causes include, without limitation, the following: power failure, fire, accident, natural disaster, work slowdown and strikes, loss of personnel, changes in funding, and acts of public authorities.

Statements of policy, fee schedules and academic regulations contained in this edition of the *Bulletin of Undergraduate Studies* supersede the statements of policy, etc., contained in previous editions of the *Bulletin*.

The University of Lowell is an Affirmative Action/Equal Opportunity University and does not discriminate on the basis of race, sex or handicap status in its educational programs, activities, or employment policies as required by Title IX of the Education Amendments of 1972 and Section 504 of the Rehabilitation Act of 1973, as amended.

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UNIVERSITY PROFILE

The University of Lowell was established by Chapter 1175, Acts of 1973, General Laws of the Commonwealth of Massachusetts, through a merger of Lowell State College and Lowell Technological Institute. Chapter 1175 directs the University to "provide, without discrimination, educational programs, research, extension, and continuing education services in the liberal arts, in engineering and the sciences, and in the professions." It also authorizes the University to "offer the adult education services of the university extension program" and it confers "general authority to award any earned doctoral degrees" with the approval of the Board of Regents for Higher Education.

Lowell State College and Lowell Technological Institute were established in the last decade of the 19th century as single purpose institutions and were charged with providing instruction in those theories and practical arts which were most suitable to the teaching profession and the textile industry. Lowell State College was chartered by the General Court of the Commonwealth on January 6, 1894 as a teacher-training institution and was assigned the responsibility for providing "the most thorough knowledge of the branches of learning and right mental training." In 1932 the institution was made a four-year college and was granted the right to confer baccalaureate degrees. In 1960, the college became a multipurpose institution by initiating non-teaching programs in the liberal arts. During the next decade and a half, the college continuously extended its mission and curriculum offerings at both the graduate and undergraduate levels and was authorized to offer degree programs in education, health professions, the liberal arts and sciences, and music.

From the time of its origin in 1895 as a proprietary textile school, Lowell Technological Institute has provided educational programs of an applied and practical nature. "Science and art will be taught," the original prospectus pointed out, "with a view to industrial and commercial applications" and for "the purpose of improving any special trade or of introducing new branches of industry." The control of the school was transferred to the state in 1918, and in 1928 it was granted collegiate status. In 1953, it became a multi-purpose technological institute. Prior to its merger with Lowell State College, the Institute phased out its textile curricula; it extended its curricular offerings in engineering, technology, science, business administration and industrial management; and it received authorization to offer degrees through the doctorate.

The merging of Lowell State College and Lowell Technological Institute has brought together two multi-purpose institutions of differing character and orientation and has made possible the creation of a comprehensive university whose strengths and resources are manifestly greater than those possessed by the previous institutions. The University occupies 35 buildings on three campuses (north, south, and west) and presently has a faculty in excess of 500 and a student enrollment of more than 14,000. The curricula of the University encompass the customary disciplines of the liberal arts and sciences as well as a wide range of professions.

MISSION OF THE UNIVERSITY

The University of Lowell, which is located in the northeast section of Massachusetts, is publicly-supported by the Commonwealth of Massachusetts. As an institution of higher education having legislative mandates in areas of research, teaching, and public service, the University seeks to discover, integrate, and transmit knowledge for the benefit of the Commonwealth and the good of society. The University offers degree programs at all degree levels through the doctorate. Although undergraduate program emphasis is upon professional areas in business, engineering, health, music, and science, the University strongly believes in the values of a liberal arts education both for its own sake and as a major component of professional preparation. Graduate program emphasis is in areas where there is a strong regional need or where the University possesses superior resources. The University also provides maximum opportunity for life-long learning through a wide variety of credit and non-credit continuing education courses.

The University is committed to the promotion of scholarly research and creative, artistic achievement. It seeks to create new knowledge in the belief that an atmosphere of original inquiry supports both the instructional and public service goals of the University. It acknowledges as a special obligation the providing of quality teaching in all academic programs and continually seeks more effective methods of imparting knowledge and understanding. Recognizing its role as a public institution, the University is committed to active involvement in community service through instruction, research, consulting, cultural events, and continuing education.

Finally, the University recognizes its responsibility for implementing the principles of equal opportunity and affirmative action and is committed to ensuring that all students and employees, particularly those in protected designations, are guaranteed the benefits of a just and equitable system.

ACCREDITATION AND PROFESSIONAL MEMBERSHIPS

The University of Lowell is accredited by the New England Association of Schools and Colleges, Inc., a non-governmental, nationally recognized organization whose affiliated institutions include elementary schools through collegiate institutions offering post-graduate instruction.

Accreditation of an institution by the New England Association indicates that it meets or exceeds criteria for the assessment of institutional quality periodically applied through a peer group review process. An accredited school or college is one which has available the necessary resources to achieve its stated purposes through appropriate educational programs, is substantially doing so, and gives reasonable evidence that it will continue to do so in the foreseeable future. Institutional integrity is also addressed through accreditation.

Accreditation by the New England Association is not partial but applies to the institution as a whole. As such, it is not a guarantee of the quality of every course or program offered, or the competence of individual graduates. Rather, it provides reasonable assurance about the quality of opportunities available to students who attend the institution.

Inquiries regarding the status of an institution's accreditation by the New England Association should be directed to the administrative staff of the school or college or to the New England Association of Schools and Colleges, Sanborn House, 15 High Street, Winchester, MA 01890.

Professional programs, as designated below, also have been accredited by appropriate professional associations. Accreditation indicates that the University is recognized and approved by associations concerned with the quality of professional education and it assures that study undertaken here has transfer value to other accredited institutions of higher education.

Professional Accreditation

Accreditation Board for Engineering and Technology
  (Baccalaureate degree programs in civil, chemical, electrical, mechanical, nuclear, and plastics engineering; electronic, mechanical, and civil engineering technology)
American Assembly of Collegiate Schools of Business
  (Undergraduate and masters business (BSBA & MBA) programs)
American Physical Therapy Association
  (Baccalaureate degree program in physical therapy)
National Accrediting Agency for Clinical Laboratory Sciences
  (Baccalaureate degree program in clinical laboratory sciences: medical technology option)
National Association for Industrial Technology
  (Baccalaureate degree program in industrial technology)
National Association of Schools of Music
  (Baccalaureate and masters programs in music)
National Council for the Accreditation of Teacher Education
  (Baccalaureate program in music education; graduate programs in education)
National League for Nursing
  (Baccalaureate and masters degree programs in nursing)

Professional Certification

Specific programs also have been reviewed for compliance with established professional criteria by the following associations and professional bodies:

American Chemical Society
  (Baccalaureate chemistry programs)
Interstate Certification Compact
  (Health, music, and elementary education; reading; secondary education: art, behavioral sciences, biology, chemistry, earth science, English, French, history, mathematics, and Spanish; administration and supervision: school principal, supervisor-director)

Professional Memberships

The University is a member of the following associations of higher education:

American Association of Colleges for Teacher Education
American Association of Colleges of Nursing
American Council on Education
American Society of Allied Health Professions
Association for Gerontology in Higher Education
Association for State Colleges and Universities
Association of University Programs in Health Administration
College Entrance Examination Board
Council of Colleges of Arts and Sciences
Massachusetts Association of Colleges of Nursing
National Association of Summer Sessions
National Association of State Directors of Teacher Education and Certification
National League for Nursing Council of Baccalaureate and Higher Degree Programs
National University Continuing Education Association
New England Board of Higher Education

UNIVERSITY ORGANIZATION AND GOVERNANCE

All University agencies, units, and departments report directly or indirectly to the President. Reporting directly are the vice presidents, the special assistant for affirmative action, the assistant for planning, budgeting and accountability, and (*ad interim*) the director of athletics. The university council, which is responsible for general institutional governance matters except insofar as these may be reserved for collective bargaining, makes policy recommendations directly to the President.

University Organization

In 1986, the President appointed an institutionally representative commission to review the organization and structure of academic units within the university. Primary considerations of this review concern the nature of the undergraduate experience, the university core curriculum, and the functional relationship of graduate programs to academic units. Commission recommendations, which will be made during the 1987 and 1988 academic years, are expected to have a major impact upon existing academic units. Accordingly, the following statements concerning lines of responsibility and authority may not accurately reflect future organizational structures. At the time when this publication was prepared, the University consisted of five organizational areas, each being supervised by a vice president (academic affairs, administration and finance, technical and resource development, university life, and university relations and development. Specific units of the university reporting to vice presidents at this time are noted at the end of this publication (pp. 542-547).

Instructional Units

In 1986, the instructional units of the university included seven colleges, a graduate school, and a continuing education and summer school.

College of Education

The offices of the dean and the faculty of the College of Education are located on the West Campus. The College of Education offers masters of education and certificates of advanced graduate study in curriculum and instruction, educational administration, and reading and language. Doctoral programs (Ed.D) are authorized in language arts and literacy, leadership in schooling, and science and mathematics education. Clinical aspects of teaching programs are conducted in the public schools of the Greater Lowell and Merrimack Valley areas. The College operates a center for field services and studies for K-12 collaboration, houses an instructional resources center, and administers the Tsongas Industrial History Center.

College of Engineering

The College of Engineering is housed in the following facilities on the North Campus: Ball Hall, Engineering Building, Falmouth Hall, Kitson Hall, Pasteur Hall, and Southwick Hall. The offices of the Departments of Electrical, Mechanical and Energy, and Plastics Engineering are located in Ball Hall. The Department of Chemical Engineering is located in the Engineering Building, Civil Engineering is in Falmouth Hall and Industrial Technology is located in Kitson Hall. Offices of the dean and assistant dean are in Kitson Hall.

College of Health Professions

The College of Health Professions is located in Weed Hall (South Campus), which houses offices of the dean, assistant dean, the Department of Clincal Laboratory Science, the Department of Health, the Department of Nursing, and the Department of Physical Therapy. Special classroom and laboratory facilities are also located in Weed Hall. Offices of the Department of Physical Education are located in the Costello Gymnasium (North Campus) and Mahoney Hall (South Campus).

Facilities in the college include a variety of fully equipped laboratories, an audiovisual laboratory, and a computer laboratory. Simulated clinical laboratories are available in the areas of chemistry, hematology, microbiology, and immunohematology. The Nursing Department provides three simulated laboratories with the most modern nursing and life support equipment. Its audiovisual laboratory is equipped for self-paced instruction in basic and advanced nursing skills. Laboratories of the Physical Therapy Department are supplied with state-of-the-art equipment. A computer laboratory, containing microcomputers and several terminals which are connected to the University's mainframe computer, is available for assisted instruction and simulation for each department in the college. The majority of clinical experiences for medical technology, health education, nursing, and physical therapy programs are conducted in public schools, health agencies, and hospitals of the Greater Lowell and Merrimack Valley areas.

College of Liberal Arts

Offices of the dean and the assistant dean of the College of Liberal Arts are located in Mahoney Hall (South Campus). Faculty offices and offices of department chairpersons are located in the following buildings:

Art	Coburn Hall, South Campus
Criminal Justice	Coburn Hall, South Campus
English	O'Leary Library, South Campus Falmouth Hall, North Campus
History	Coburn Hall, South Campus
Languages	Coburn Hall, South Campus
Philosophy	Mahoney Hall, South Campus
Political Science	Coburn Hall, South Campus
Psychology	Mahoney Hall, South Campus
Sociology	Coburn Hall, South Campus

Facilities of the college include experimental laboratories for animal and human learning, a microcomputer laboratory, a criminalistics laboratory, language laboratory facilities, theatre arts workshops, and a performing theatre. Practicum experiences for the various curricula are conducted in social and governmental agencies and in business firms of the Greater Lowell and Merrimack Valley areas.

College of Management Science

The College of Management Science is located in Falmouth and Pasteur Halls on the North Campus. Offices of the Department of Management Science are located on the third floor of Falmouth Hall. The Accounting and Economics Departments are located on the second and third floors of Pasteur Hall. Offices of the dean and assistant dean are in Pasteur Hall.

College of Music

The College of Music is located on the South Campus and housed in a fully equipped performing arts facility. Performances are presented both in Durgin Concert Hall and Fisher Recital Hall. Durgin Concert Hall (with seating for one thousand) features a professional stage house and is the scene of concert, ballet, musical theatre, and recital presentations of the University of Lowell Foundation Series. Fisher Recital Hall, seating approximately two hundred and fifty and featuring a Schlicker organ of twelve ranks, serves as the performance space for faculty and students. Other facilities include an electronic music studio; two electronic piano classrooms; and a fully equipped state-of-the-art recording area.

College of Pure & Applied Science

Offices of the College of Pure & Applied Science are located in Olsen and Olney Halls (North Campus). Offices of the dean and assistant dean are located in Olney Hall. Offices of department chairpersons are located in the following buildings:

Biological Sciences	Olsen Hall
Chemistry	Olney Hall
Computer Science	Wannalancit
Earth Sciences	Olney Hall
Mathematics	Olsen Hall
Physics and Applied Physics	Olney Hall

Modern facilities and equipment in the Olsen, Olney, and Pinanski buildings and in Weed Hall (South Campus) include teaching laboratories, modern computer equipment, undergraduate and graduate research facilities, office research modules and such service areas as animal quarters, rooms for instrumentation, preparation, temperature and humidity control as well as X-ray, electron microscope (transmission and scanning), greenhouse and library facilities.

Continuing Education and Summer School

Continuing Education offers degree programs at both the associate and baccalaureate levels, as well as credit and non-credit courses for part-time, non-matriculating students. A broad spectrum of courses is offered during the late afternoon and evening to fulfill the educational needs of employed persons and others in the Merrimack Valley area who are restricted to part-time attendance. All continuing education degree programs are under the supervision and control of resident University faculty. Continuing education offices are located in Cumnock Hall (North Campus).

Graduate School

The Graduate School offers extensive professional and research programs at both masters and doctoral levels. Master level programs are offered in 31 areas. Doctoral programs are offered in electrical, mechanical, and plastics engineering (Eng.D.); in computer science (Sc.D.); in language arts and literacy, leadership in schooling, science and mathematics education (Ed.D.), and in chemistry and physics (Ph.D.). Many courses are offered in the late afternoon and evening, and most programs can be completed on a part-time basis. Offices of the Graduate School are located in Falmouth Hall, room 311.

Academic Support and Service Facilities

Academic support and service facilities include the computer center, the University libraries, and the research foundation.

Academic Computer Center

The University academic computer center located in the Olsen building provides a wide range of facilities and services in support of classroom teaching and research at both the undergraduate and the graduate level. The central computer facility consists of two CDC CYBER 170-825 computer systems with a full complement of peripherals and terminals to support batch, remote batch, and interactive time-sharing environments. The computer systems provide direct access to their resources through a telecommunications network. The operating system software includes assembler, FORTRAN, COBOL, BASIC, ALGOL, APL, PASCAL, MIX , and a library of applications packages including SPSS, TSP, BMDP, IMSL, SLAMII, SPREAD, MINITAB, ACSL, ANSYS, MATRIX, SIMSCRIPT, INFOFETCH, MPOS, CD2000(CAD/CAM), VISUAL, DI3000 presentation graphics etc. The academic computer center also operates a Data General MV/8000 computer with 40 terminals for use by the faculty and students in the College of Engineering. The computer facilities are supported by the academic computer center organization with a professional and support staff of 15 persons.

In addition to the central computing facilities supported by the academic computer center, nearly 100 minicomputer systems are installed in various colleges and departments throughout the University. These facilities, which are operated and maintained at the college or the department level, include the following: Apollo network (40 nodes); COMPUTER-VISION; DEC VAX 11/780 (three), 11/750 (four), 11/730, micro VAX (five), DEC PDP 11's (thirty); DG MV/4000 (two); HP-1000; and Wang VS/80 (two), VS/45 (two).

University Libraries

The University libraries, which consist of the Alumni-Lydon Library (North Campus) and the O'Leary Library (South Compus), have a seating capacity of 2,000 and are completely automated. Present library holdings include over 300,000 books and periodicals and a large number of such non-print materials as video tapes, films and microforms. The O'Leary Library provides resources in the social sciences, humanities, and health areas and houses the ERIC microfiche collection (Educational Resources Information Center). Music collections and facilities of O'Leary Library include listening stations, audio recordings, and over 7,000 music scores. The Alumni-Lydon Library houses collections for engineering, science, and business. Special collections of the University Libraries include the collections of the American Association of University Women (Greater Lowell Chapter), Boston and Maine Railroad Historical Society, Lowell Historical Society, Lowell Museum, Manning Family, Middlesex Canal Association, Proprietors of the Locks and Canals on the Merrimack River, University Archives, and a collection of regional histories. Other valuable resources include educational media and New England maps published by the Geological Survey of the U.S. Department of the Interior. The University libraries provide interlibrary loan services and also function as a U.S. Government depository.

Research Foundation

The Research Foundation was established in 1950 as a not-for-profit organization which operates from income derived from research funded by private industry, foundations, and government agencies. Housed in a modern building adjacent to the main resident hall complex of the North Campus, the foundation contains major support facilities for faculty and student research projects, the foundation provides a mechanism for the administration and fiscal management of all academic grants and contracts. Two auxiliary enterprises, the Metrology and Testing Divisions, help to defray the overhead costs of the facility. Metrology services are provided to assist industry and government through the repair and calibration of electronic test equipment with traceability to the National Bureau of Standards. This service is available from the foundation or its fully equipped mobile laboratory. Also based at the foundation are the Centers for Atmospheric Research and for Tropical Disease.

As part of its close cooperation with the University, the Research Foundation employs both graduate and undergraduate students from the University on a part-time basis. These students gain practical experience which often leads to an advanced degree. In addition to the research which is carried out on campus, research projects have been conducted in Thailand, Greece, Italy, Germany, and Algeria. Currently, research projects are being conducted in Labrador, England, Jordan, Brazil, Egypt, and other parts of the world where the University is becoming known for its significant expertise. For further information, contact Mr. Edward F. Miller, Jr., Executive Director, University of Lowell Research Foundation, 450 Aiken Street, Lowell, Massachusetts 01854.

University Council

Subject to the final authority of the Board of Trustees and the Board of Regents of Higher Education, the University Council is the principal legislative and policy-making advisory body of the University community. In accepting this responsibility the council recognizes a duty to respect and safeguard the civil liberties, academic freedoms, and professional ethics of individual members of the University, associated groups of persons within the University, and individuals or groups invited to the University. For this purpose, members of the student body, the faculty, the administration, the professional staff, and the non-professional staff have equal claim to the protection of the council.

Powers and Functions of the Council

1. General responsibility for non-academic matters of campus life, such as parking regulations, cultural events, and social activities;
2. Legislative authority over all University-wide academic policies;
3. Legislative authority concerning standards for student discipline in academic cases;
4. Legislative authority for the academic calendar to the extent that it does not alter the terms and conditions of faculty employment;
5. General authority to study and to make recommendations within the University community on matters it deems appropriate, including long-range planning, the annual budget, the allocations of available resources, and other matters of compelling significance;
6. General authority, subject to the approval of the president and the Board of Trustees, to make recommendations to local, state, and federal governing boards;
7. General authority to establish such committees as appropriate to carrying out its powers and functions; and
8. General authority to draw up rules and regulations for its own operation.

Council Membership

1. Twenty-one (21) faculty members; one (1) elected from each college, thirteen (13) elected at large, and the chairperson of the faculty;
2. Ten (10) students; eight (8) undergraduates, and two (2) graduates to include the President of the Interdormitory Council, the President of the Graduate School Association, and the President of the Student Government;
3. Six (6) administrators: the Vice President for Academic Affairs, the Vice President for University Life, the Vice President for Administration and Finance, two administrators elected at large by administrators of the University, and one college dean elected by the college deans of the University;
4. Three (3) members at large to be appointed by the president;
5. Two (2) members of the alumni living in the Greater Lowell community and not employees of the University of Lowell, appointed by the Alumni Association;
6. The immediate past chairperson of the University Council as ex officio non-voting member.

ADMISSION POLICIES

The following pages describe in detail University requirements and processes concerning the admission of high school graduates, non-traditional students, transfer students; the admission of international students and candidates for second degrees; the admission of non-matriculating students; and the readmission of previously enrolled University students. These pages also provide basic information concerning degree programs, applicant inquiries, application deadlines, advanced placement, health certification requirements, and the Massachusetts transfer compact.

GENERAL POLICIES

Admission to all baccalaureate day programs is made through the office of admissions and according to established undergraduate policies. Admission to programs of continuing education or to summer school, which is made through the office of continuing education, does not constitute admission to baccalaureate day programs and implies no commitment, per se, for subsequent application of continuing education or summer school courses to baccalaureate day programs. It is the policy of the University of Lowell that students seeking admission to either regular or continuing education programs will be evaluated on their merits and (as prescribed in applicable federal and state laws) without respect to their race, color, creed, national origin, age, sex, handicap, or marital status. The University makes a special attempt to attract students from various racial backgrounds and disadvantaged environments.

The admission policies of the University of Lowell, which are in keeping with its mission and the guidelines of the Board of Regents, specify procedures for admitting three types of applicants for undergraduate degrees: 1) high school seniors and individuals who have graduated from high schools within three years, 2) non-traditional students, and 3) transfer students. Accordingly, these policies not only protect the intellectual integrity and strength of the University by requiring standards of preparation and objective evidence of the student's potential for success but also provide access for a diverse student population, including traditional and non-traditional students and students with special needs and talents. Individuals who are admitted by the office of admissions must be accepted under one of the following categories:

1) as undeclared students (entering as freshmen or transfer students with less than 60 semester credits*) who wish to establish initial matriculation for a degree which is offered by one of the colleges of the University of Lowell;

2) as declared students (entering as freshmen or transfer students) who wish to establish initial matriculation for a Lowell degree and who have a commitment to an academic major or professional program which is offered by one of the colleges of the University;

3) as provisional students of the College of Liberal Arts in either the Educational Opportunities Program for non-traditional under-represented students or the Second Chance Program for adults who wish to initiate a university course of study or who wish to resume or to change a previously initiated university program;

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* Several colleges do not accept undeclared students who transfer more than 30 credits. Such students are required to declare majors if applying to these colleges.

4) as declared students with advanced standing who wish to pursue a second baccalaureate degree at Lowell after having completed an initial baccalaureate degree at the University or other accredited institution; or

5) as non-matriculating students admitted on a semester-by-semester basis under provisions governing special plans for non-degree studies which are designated at the time of admission.

To be admitted for undergraduate study, applicants must present records of academic performance which indicate a reasonable probability of success in their chosen programs or colleges. For regular freshman admission to an undergraduate college or degree program, probability of success is measured by an individual's high school record, class standing, and standardized test results and/or by his or her academic record at the University of Lowell for prescribed provisional courses of study in EOP, Second Chance, summer school, or continuing education programs. For regular transfer admission to an undergraduate college or degree program, probability of success is measured by an individual's previous academic record at some other accredited institution of higher education. Within the space available in particular programs, admissions are offered first to those whose performance record indicates the highest probability of success in the chosen college and/or program. Specific academic standards requirements are described below under headings for admission categories.

Applicant Inquiries Concerning Admission

The University welcomes correspondence from prospective students who may need assistance in adapting their high-school programs to satisfy specific program requirements. Such correspondence should be addressed to the Office of Admissions, University of Lowell, Lowell, Massachusetts 01854. Requests for application forms should be directed to the same office.

Choice of Program: Academic Major

Entering freshmen who prefer to test their abilities and interests or who wish to explore several areas of study before identifying themselves with one of the baccalaureate day programs can request admission as undeclared students. Students transferring with 60 or more credits may not request status as undeclared students and must enter the University with a commitment to an academic major or professional program. Enrollments in certain professional programs (including programs of the College of Health Professions in clinical laboratory sciences, nursing, and physical therapy) are limited. Undeclared students are advised that openings in a desired professional program may be inadequate to accomodate all qualified undeclared student applicants at the time when program declarations must be made (upon completion of 60 credits). When resources of a college or program render it necessary to establish admission quotas, differential admission criteria above and beyond specified admission requirements will be applied in the selection of applicants as matriculating students.

Depending upon enrollment restrictions, application deadlines vary for engineering, management science, clinical laboratory sciences, nursing, and physical therapy programs. Individuals who apply after the closing dates which are specified for these programs may be offered waiting list status. An applicant who has been approved for admission to restricted programs will be advised in his or her letter of the specific deadline for accepting an offer of admission and for making a required tuition deposit. For all other baccalaureate programs, the University operates on a rolling admission plan.

To confirm an offer of University admission, an applicant who has been approved for admission to any program other than those which are specified as having enrollment restrictions must make a required tuition deposit within twenty days of the date on his or her official acceptance letter. A refund of the tuition deposit will be made to individuals who notify the office of admissions by June 1st that they wish to cancel their University admission. A refund of the tuition deposit will not be made after June 1st.

Baccalaureate degree programs are offered by the Colleges of Engineering, Health Professions, Liberal Arts, Management Science, Music, and Pure and Applied Science. Continuing education degree programs at both the associate and baccalaureate degree levels are offered in the evening. Applicants who wish to apply for continuing education programs should address their inquiries to the Office of Continuing Education, Cumnock Hall, North Campus. Teacher-preparation programs are offered at the graduate level only and are not open to undergraduate students.

Programs of the College of Engineering

Chemical Engineering
Civil Engineering
Electrical Engineering
Industrial Technology
Mechanical and Energy Engineering
Nuclear Engineering
Plastics Engineering

Programs of the College of Health Professions

Clinical Laboratory Sciences*
Health Education
Nursing
Physical Therapy+

* Options availabe in medical technology, clinical laboratory sciences, and exercise physiology.

+Program terminates with the class of 1991. Freshman students will not be admitted after September 1987.

Programs of the College of Liberal Arts

Administration of Criminal Justice
American Studies
Art
English
French
History
Modern Languages
Philosophy
Political Science
Psychology
Sociology
Spanish

Programs of the College of Management Science

Business Administration+
Economics
Industrial Management

+Concentrations are available in Accounting, Economics, Marketing, and Management

Programs of the College of Music

Music
Music Education
Music History and Literature
Music Theory
Performance+

+Program areas of emphasis include: Sound Recording Technology, Music & Business, and Jazz Studies.

Programs of the College of Pure and Applied Science

Biological Sciences*
Chemistry
Computer Science
Environmental Sciences##
Mathematics+
Meteorology
Physics#
Radiological Health Physics

* Biotechnology option is available.
Geology option is available.
+ Options are available in Pure or Applied Mathematics, Computer Programming, and Statistics.
# Options are available in Optics and Applied Physics

Change of Program (Academic Major) After Application

Individuals who are admitted to specific programs or to a college as undeclared students and who wish to change their designations of program or college admission may do so by notifying the office of admissions. Such changes of designation must reach the office of admissions no later than one month prior to the date established for freshman registration and will be approved only if space in the desired program or college permits and the applicant has satisfied all admission requirements for the newly designated college or program. Changes in program designation can be made after registration by filing requests for change of major and/or intercollegiate transfer within the University; however, they cannot be made later than one month prior to the registration date through the office of admissions.

ADMISSION POLICIES FOR TRADITIONAL STUDENTS

Graduating high-school seniors and high-school graduates who wish to be admitted to the University as matriculating students must comply with the following:

1) file an official application form with the University of Lowell prior to April first,
2) request high-school principals or guidance directors to forward to the office of admissions transcripts of secondary school grades—including grade reports for at least the first quarter of the senior year,
3) complete and file the College Board Student Descriptive Questionnaire, and
4) arrange to take the College Entrance Examination Board Scholastic Aptitude Tests.

Detailed information concerning the College Entrance Examination Board tests and the dates throughout the year on which they are administered may be secured from the office of admissions of the University of Lowell, high-school principals or guidance directors, or the Educational Testing Service, Princeton, New Jersey 08540. Special information is provided in the following sections concerning required aptitude examinations for applicants to music programs and for satisfication of department language requirements through the Foreign Language Achievement Tests of the College Entrance Examination Board. Following receipt of application forms, transcripts of high-school records, and Scholastic Aptitude Test scores, the office of admissions may arrange appointments for personal interviews of applicants. The responsibility for having all credentials forwarded to the University of Lowell rests solely with the applicant.

Admission Requirements for Graduating High-School Seniors and High-School Graduates

The general expectation is that applicants will present course work which has been taken within college preparatory curricula. However, the office of admissions will evaluate the academic units of vocational technical school (Chapter 74) graduates to determine their relevance for University curricula. The ultimate judgment concerning such equivalency rests solely with the University of Lowell. The following pages specify prescribed high school unit requirements which will be imposed over the next three years and other qualitative requirements for the admission of freshmen students. Applicants must satisfactorily complete prescribed units prior to enrollment. Table I specifies the high school unit distribution which is required for general University admission. Tables II—V specify high school unit distributions which are required by specific programs. An applicant who has a minor academic unit deficiency may be provisionally accepted for college admission pending correction of deficiency in summer school.

Table I

Prescribed High School Unit Requirements
General University Admission

	Students Entering the University in:	
	1986-1987	1987 & after
English +	4	4
Mathematics	2	3
Social Sciences/History	3	3
Natural/Physical Science (with labs)	2	2
Foreign Language	#	2
Electives (selected from areas above)	5*	2
Total Prescribed Units	16	16

+ College preparatory courses in composition and literature must include the development of writing and comprehension skills. Students should be familiar with and practice the different modes of composition.

Foreign language units are recommended for students entering in 1986-87; other electives may be taken in place of languages.

* Except for students who seek admission to programs which require two years of foreign language, Chapter 74 (vocational-technical school) students may substitute two years of computer science.

In addition to the 16 required units, secondary school students have a minimum of 4 additional units for electives. The University encourages all students to broaden their college preparatory experience by electing courses in art, languages, literature, music, social studies, and the sciences. Chapter 74 students may offer vocational technical course work for three of the required elective units.

Table II

Prescribed High School Unit Requirements
College of Health Professions

	Students Entering the University in:	
	1986-1987	1987 & after
English +	4	4
Mathematics	2	3
Social Sciences/History	3	3
Natural/Physical Science (with labs)**		
Biology	1	1
Chemistry	1	1
Foreign Language	#	2
Electives (selected from areas above)	5*	2
Total Prescribed Units	16	16

+ College preparatory courses in composition and literature must include the development of writing and comprehension skills. Students should be familiar with and practice the different modes of composition.

** An academic unit in physics is recommended.

# Foreign language units are recommended for students entering in 1986-87.

* Chapter 74 (vocational-technical school) students may substitute two years of computer science.

In addition to the 16 required units, secondary school students have a minimum of 4 additional units for electives. The University encourages all students to broaden their college preparatory experience by electing courses in art, languages, literature, music, social studies, and the sciences. Chapter 74 students may offer vocational technical course work for three of the required elective units.

Table III

Prescribed High School Unit Requirements
College of Pure and Applied Sciences,
and Industrial Management Program
(College of Management Science)

	Students Entering the University in:	
	1986-1987	1987 & after
English +	4	4
Mathematics##		
Algebra (quadratics and beyond)	2	2
Plane Geometry	1	1
Trigonometry	.5	.5
Social Sciences/History	3	3
Natural/Physical Science (with labs)**	2	2
Foreign Language	#	2
Electives (To be selected from areas above)	3.5*	1.5
Total Prescribed Units	16	16

+ College preparatory courses in composition and literature must include the development of writing and comprehension skills. Students should be familiar with and practice the different modes of composition.

## Calculus is strongly recommended for students who plan to enter physics.

** One unit required in chemistry or physics. Preference given for both chemistry and physics. Applicants not presenting both subjects are urged to pursue the appropriate course in summer school.

# Foreign language units are recommended for students entering in 1986-87.

* Chapter 74 (vocational-technical school) students may substitute two years of computer science.

In addition to the 16 required units, secondary school students have a minimum of 4 additional units for electives. The University encourages all students to broaden their college preparatory experience by electing courses in art, languages, literature, music, social studies, and the sciences. Chapter 74 students may offer vocational technical course work for three of the required elective units.

Table IV

Prescribed High School Unit Requirements College of Engineering

	Students Entering the University in: 1986-1987	1987 & after
English +	4	4
Mathematics≠≠		
Algebra (quadratics and beyond)	2	2
Plane Geometry	1	1
Trigonometry	.5	.5
Social Sciences/History	3	3
Natural/Physical Science (with labs)**	2	2
Foreign Language	≠	2
Electives (To be selected from areas above)	3.5*	1.5
Total Prescribed Units	16	16

+ College preparatory courses in composition and literature must include the development of writing and comprehension skills. Students should be familiar with and practice the different modes of composition.

≠≠ Calculus is strongly recommended.

** One unit is required in chemistry or physics. Preference given for both chemistry and physics. Applicants not presenting both subjects are urged to pursue the appropriate course in summer school.

≠ Foreign language units are recommended for students entering in 1986-87.

* Chapter 74 (vocational-technical school) students may substitute two years of computer science.

In addition to the 16 required units, secondary school students have a minimum of 4 additional units for electives. The University encourages all students to broaden their college preparatory experience by electing courses in art, languages, literature, music, social studies, and the sciences. Chapter 74 students may offer vocational technical course work for three of the required elective units.

Table V

Prescribed High School Unit Requirements College of Engineering (Five Year Program: Track II)

	Students Entering the University in: 1986-1987	1987 & after
English +	4	4
Mathematics≠≠		
Algebra (quadratics and beyond)	2	2
Plane Geometry	1	1
Social Sciences/History	3	3
Natural/Physical Science (with labs)**	2	2
Foreign Language	≠	2
Electives (To be selected from areas above)	4*	2
Total Prescribed Units	16	16

+ College preparatory courses in composition and literature must include the development of writing and comprehension skills. Students should be familiar with and practice the different modes of composition.

≠≠ Limited admission is provided under the five-year Engineering Track II program for students having satisfied algebra and geometry requirements but who have not completed trigonometry. Preference is given to such students who offer both physics and chemistry.

** One unit is required in chemistry or physics. Admission preference is given for both chemistry and physics.

≠ Foreign language units are recommended for students entering in 1986-87.

* Chapter 74 (vocational-technical school) students may substitute two years of computer science.

In addition to the 16 required units, secondary school students have a minimum of 4 additional units for electives. The University encourages all students to broaden their college preparatory experience by electing courses in art, languages, literature, music, social studies, and the sciences. Chapter 74 students may offer vocational technical course work for three of the required elective units.

Qualitative Requirements for the Admission of Freshman Students

Graduating high-school seniors (including applicants graduated from secondary schools within the last three years) who seek freshman admission as matriculating students must comply with the following:

1) present a minimum high school grade point average of 2.50 (on a 4.00 scale),
2) achieve SAT scores as specified by the college within the University to which they apply, and
3) comply with the class ranking requirement of the SAT/Class Rank Eligibility Index.

Table VI

SAT Requirements

College	Programs	Verbal Score	Math Score	Combined Score
Engineering	Engineering (Four Year Standard Program)	400	500	900
	Engineering (Five Year Track II Program)	400	400	800
	Industrial Technology	400	450	850
Health	All	450	450	900
Liberal Arts	All	400	400	800
Management	All	450	450	900
Music	All	400	400	800
Science	Computer Science	450	550	1000
	All Other Sciences	400	500	900

Music Aptitude and Proficiency Examinations (College of Music)

Students who wish to apply for music programs are required to demonstrate vocal or instrumental ability in a performance audition with a member of the faculty of the College of Music. The student is also required to achieve satisfactory scores on both a written test of music fundamentals and a brief examination in aural comprehension. Performance auditions and theory testing are scheduled throughout the academic year. Applicants are not invited to take these special music tests at the University until all other credentials have been approved by the office of admissions.

Table VII

SAT/Class Rank Eligibility Index

The following index specifies the class rank (listed as upper percentile in graduating class) which freshman applicants must have achieved to qualify for admission. The combined scores noted below must reflect the minimum verbal and mathematics requirements cited above. Except as specifically noted below, class rank cannot compensate for combined SAT scores which are below the minimum University requirement of 800.

Combined SAT Scores	Upper Class Rank	Combined SAT Scores	Upper Class Rank
800-849	45%	1050-1099	70%
850-899	50%	1100-1149	75%
900-949	55%	1150-1199	80%
950-999	60%	1200-1249	85%
1000-1049	65%	1250-1299	90%
1300-	N/A		

In unusual cases where marked deviations exist for a given applicant between low SAT math or Verbal scores and the class rank and/or the four-year average of the secondary cumulative record, the admissions staff will give the secondary record primary emphasis. Personal interviews or recommendations may be used, at the discretion of the admissions staff, in order to assist in estimating the individual's potential for academic achievement. Whenever the combined SAT score is less than 800, however, no additional consideration will be given to candidates unless they have ranked in the upper class percentiles as noted below.

Combined SAT Scores	Upper Class Rank	Combined SAT Scores	Upper Class Rank
700-749	10%	750-799	25%

Application Procedures for International Students

Applicants who are residents of foreign countries are required to supply the office of admissions with SAT scores, secondary school and/or college records, as well as all other application materials, submitted in English, no later than twelve months in advance of their expected date of admission. All international students must file the financial resource form, "Certification of Finances" which evidences sufficient financial resources for their years of study at the University.

Applicants must have considerable facility in speaking and writing English, and prospective students whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL). Students are responsible for making arrangements for taking this test and should address inquiries to: TOEFL, Educational Testing Service, Princeton, New Jersey 08540, U.S.A. The completed application form should be returned to the Testing Service at Princeton well in advance of the application deadline. The test fee, which should be remitted with the application, entitles the student to have his test score sent to three different institutions. Registration for the Test of English as a Foreign Language does not constitute application for admission to the University of Lowell. The bulletin of information, obtainable without charge, contains a description of the test as well as rules regarding application, fees, reports, and the conduct of the test, lists of examination centers, examination dates, and an application blank. On the appplication for the test, the student should specify that his score be sent to the Office of Admissions, University of Lowell, Lowell, Massachusetts 01854. In addition to the TOEFL, an admitted student may be required to report to the admissions office to make arrangements for taking an English placement test for foreign students prior to registration. Results of this test may determine the courses for which the student will be permitted to register in his or her program of study.

Application Procedures and Requirements for Non-Graduates of High Schools

Applicants who have not graduated from high school may be admitted to the University upon satisfactory completion of the General Educational Development tests and receipt of a certificate of high-school equivalency. Such students are required to take the Scholastic Aptitude Tests of the College Entrance Examination Board prior to their application and to present scores which are acceptable to the University. Admissions procedures for students possessing certificates of high-school equivalency are the same as those which are prescribed for graduating seniors and high-school graduates.

ADMISSION POLICIES FOR NON-TRADITIONAL STUDENTS

Non-traditional students who seek admission as baccalaureate degree candidates may seek admission to the University through two programs: 1) the full-time Educational Opportunities program for under-represented students and 2) the part-time Second Chance program (three to eleven credits per semester) for adults.

Educational Opportunities Program

The Educational Opportunities Program (EOP) is a structured plan of matriculated studies for non-traditional under-represented students whose high-school preparation for the University curriculum of their choice has been inappropriate and/or whose high-school achievement and SAT scores evidence a need for individualized assistance. Individuals who are admitted to the University in this program are granted matriculated status on a semester-by-semester basis and may remain enrolled in this program as undeclared students in the College of Liberal Arts for a maximum period of four full-time semesters and two summer sessions. Continuous enrollment in the Educational Opportunities program is permitted only for individuals who evidence sufficient academic promise to warrant predictions of continued success.

Admission

Potential participants in the Educational Opportunities program are identified from the pool of University applicants by the director of special academic services and EOP staff. After reviewing the credentials of potential applicants, the director arranges a personal interview with each individual who expresses an interest in the Educational Opportunities program. Through personal interviews, assessment of school records and recommendations from teachers, counsellors, and other individuals who are personally acquainted with applicants, the director of special academic services and EOP staff seek information concerning the nature and scope of each individual's interests and select for admission those candidates whose potential and motivation for higher education indicate an acceptable probability of academic success. Applicants are formally notified by the office of admissions of their program acceptance.

An individual who wishes to accept an offer of admission to the Educational Opportunities program must make a non-refundable tuition deposit of $50.00. Receipt of this deposit is required (preferably by April 15th for fall semester admission or November 15th for spring semester admission) prior to registration for EOP and University courses. An accepted applicant must file the standard University health questionnaire and a notarized certificate of Massachusetts residency to qualify for in-state tuition rates.

Provisional Programs of Study

A student preceptor and a faculty advisor assist the EOP student in the selection of a provisional program of regular University and supplemental EOP courses. The objective of supplemental courses is to develop those skills and habits which are fundamental to successful academic competition at the University of Lowell. Such courses are individualized and self-paced in nature and emphasize the development of study, note-taking, and test-taking skills and the mastery of the basic academic tools of reading, oral and written communication, computation, and mathematics. The comprehensive Educational Opportunities program requires attendance for all activities and provides support and advising for program participants.

Continued Matriculation and Qualification for Declaration of Major

At the end of each semester of full-time enrollment (12 or more contact hours per week of University courses and supplemental courses), the record of each participant is reviewed by the director of special academic services and the EOP advisory board for the purpose of assessing individual progress and achievement. All participants are required to have passed 30 credits of University courses by the end of their fourth semester of enrollment and to have achieved 15 credits with "C" grades or better. Participants whose progress is determined to be inadequate are dropped from the University. Individuals who are dropped from the University are ineligible to pursue course work as University students in either day or continuing education sessions.

Declaration of Major and Intercollegiate Transfer

At the end of any period of enrollment (including both semester and summer sessions) in which they have accumulated 15 credits of University courses with grades of "C" or better, participants in the Educational Opportunities program may declare a major within the College of Liberal Arts or, subject to pertinent regulations of individual college programs, they may apply for transfer to another college for the program of their choice. The initial change of student status from provisional EOP student to that of declared major student in either the College of Liberal Arts or another college is not included in the computation of the number of changes of major or the number of intercollegiate transfers which can be made by students during their undergraduate study at Lowell and accordingly is not governed by these policies.

When applicable to the curriculum and college to which individuals apply, all University courses which have been passed with grades of "CD" or better will be recognized and will be computed into subsequent grade-point averages. Supplemental EOP courses will not be recognized for credit. Nor will University courses which are completed with grades less than "CD" be computed into subsequent grade-point averages or credited to baccalaureate programs.

Financial Assistance

Participants in the Educational Opportunities program may be eligible for financial assistance through federal loans and grants, state programs, and University tuition remission. Since financial assistance through federal loan and grant programs is subject to federal definitions of "normal progress" and may not be extended beyond a period of five years of undergraduate study, program participants are advised that federal financial assistance cannot be guaranteed for periods of baccalaureate studies in excess of five years or when "normal progress" cannot be certified.

Participation by EOP Students in University Programs

Participating students in the Educational Opportunities program have full access to dormitory housing, food services and University activities. However, EOP students may not participate in varsity athletics.

Second Chance Program

The Second Chance program is a plan of part-time studies (three to eleven credits per semester) which is available to adults, with or without previous collegiate experience who have special needs. Admission to the Second Chance program is not open to students of the University of Lowell with regular status (including students who have been granted reduced loads) or to individuals who have graduated from high school within the previous three years. Nor is the Second Chance program available as an alternative admissions option for individuals who were previously enrolled in the University of Lowell as matriculating day students unless they have been absent from the University for two or more years prior to the date of their requested readmission and have withdrawn from the University in satisfactory academic standing.

The Second Chance program has been instituted to meet the needs of three types of students: 1) those whose desire to begin or to continue their education has been frustrated or interrupted by family or employment commitments, 2) those who may feel they are "too old" or "too out of practice" to compete full-time in the classroom with recent high-school graduates, and 3) those whose current employment makes impossible their attendance at evening programs of continuing education.

Application Procedures

Individuals who are interested in the Second Chance program should arrange an interview with the program coordinator, Professor Joyce Denning, Coburn Hall, Room 201, extension 2479. If the Second Chance program appears to suit his or her needs, the individual should complete the appropriate application form with the coordinator, who will forward the completed application to the office of admissions. Ideally, applicants who are seeking admission for the fall semester should schedule an interview and complete all application procedures before March 15. Applicants for the spring semester are advised to complete application procedures before October 15. In keeping with the University policy on admissions, however, individuals may apply for September admission up to June 1. Such applicants should be aware that there will be a restricted choice of course offerings available at this time.

Applicants for admission are required to complete the following steps by the deadlines cited above:

1) complete the application form of the University of Lowell,
2) make payment of the application fee,
3) request high school principals to forward to the Second Chance office transcripts of secondary school grades or, for a student with high school equivalency, request the Department of Education to forward to the Second Chance office certification of high school equivalency, and
4) request registrars of all institutions of higher education attended to forward transcripts of previous course work to the Second Chance office, whether such course work is presented for recognition or not.

The responsibility for having all credentials forwarded to the Second Chance office rests solely with the applicant.

Individuals are admitted for provisional programs on a space available basis through an open admissions process and are granted regular status on a semester-by-semester basis as undeclared students in the College of Liberal Arts. Applicants are formally notified by the office of admissions of their program admission. Individuals who are accepted for admission must make a non-refundable tuition deposit of $50.00. Receipt of this deposit is required by April 15th or November 15th for individuals to register during the designated fall or spring pre-registration periods. Prior to registration, an accepted applicant must file the standard University health questionnaire and a notarized certificate of Massachusetts residency to qualify for in-state tuition rates.

Provisional Programs of Study

The program coordinator will determine whether the student should be admitted for a 15 or 30 credit provisional period and may require an interview with students who have not previously discussed their plans or whose previous college course work justifies further discussion. Provisional programs of study are developed by the student in consultation with the program coordinator. Students who have completed 15 or more semester credits at an accredited college within the previous ten years are admitted to pursue a program of provisional studies of 15 semester credits. Students who have completed less than 15 credits at an accredited college within the previous ten years, or who have never attended an institution of higher education, are admitted to pursue a program of provisional studies of 30 semester credits (All students entering the program in Nursing must fulfill a provisional program of 30 credits). At the end of each semester of full-time enrollment (or equivalent period of part-time studies), the record of each Second Chance student is reviewed by the program coordinator and a committee of faculty members of the College of Liberal Arts for the purpose of assessing individual progress and achievement. Participants whose progress is determined to be inadequate are dropped from the University. Students may remain enrolled for a maximum provisional program of 30 semester credits.

Continued Matriculation in the Second Chance Program and Qualification for Regular Status

Second Chance students who have satisfactorily completed their provisional programs and who wish to continue their studies on a part-time basis are permitted to do so in many undergraduate programs of the University. Inquiries concerning the availability of undergraduate programs for part-time students should be addressed to the program coordinator. Students who wish to continue their studies on a full-time basis are permitted to petition for admission to all programs of the University. However, individuals should understand that openings may be limited or unavailable in some programs and that some programs have established admission requirements which mandate the completion of specific prerequisite courses and/or the achievement of higher grade-point averages than are specified by University retention standards. The program coordinator will advise an individual of these requirements when he or she has determined a choice of curriculum and will assist in the development of a provisional program which is relevant to that curriculum.

Following satisfactory completion of provisional programs, students are recommended for programs of their choice (subject to the restrictions noted in the preceeding paragraph) by the program coordinator, who forwards a recommendation (together with transfer evaluation forms and records of all transfer and University courses) to the appropriate college dean and, subsequently, to the appropriate department chairperson if the applicant has made a declaration of major. A transfer from Second Chance to a regular college program is not regarded as an intercollegiate transfer and is not subject to the University limitation concerning such transfers.

Residency Requirement for Students With Continuing Part-Time Status

Second Chance students who wish to continue their part-time status following their acceptance in a major program are required to present a minimum of 30 semester credits in University day classes and 15 credits of University courses in their majors. Upon the approval of the appropriate college dean, up to 15 credits of the minimum University residency requirement of 30 credits may be satisfied through completion of day courses in the University of Lowell Summer School. (Cf. "Academic Policies: Residency Requirements.") Records of these students will carry the notation "SC" for the year of graduation as long as they maintain part-time status.

Tuition, Fees, and Federal Assistance Eligibility

Individuals who are enrolled in the Second Chance program are charged tuition fees in accordance with rates for part-time students and are required to pay all University fees when applicable to their programs except for the student activity and student union fees. Since financial assistance through federal loan and grant programs is subject to federal definitions of "normal progress" and may not be extended beyond a period of five years of undergraduate study, program participants are advised that federal financial assistance cannot be guaranteed for periods of baccalaureate studies in excess of five years or when "normal progress" cannot be certified.

APPLICATION PROCEDURES AND REQUIREMENTS FOR TRANSFER STUDENTS

In general, the University of Lowell will accept on an hour-for-hour basis semester credits with grades of "C" (2.0 on a 4.0 scale) or better as shown on official transcripts of record which are received directly from other accredited collegiate institutions and which are applied to an initial baccalaureate degree.* (However, transfer credit for a course passed with a grade lower than "C" *may* be granted when a student has passed, with a grade of "C" or better, a course taken subsequently which is sequential and/or linked to the earlier course. In such a case, a student must petition both his major department and the department offering the equivalent course at the University of Lowell. After reviewing the record, the respective department chairpersons *may* permit the award of transfer credit. The concurrence of both chairpersons is required.) Quarter credits are recognized on a prorated basis of three quarter credits to two semester credits. Preference for admission to the University is based upon the record of each individual transfer applicant at the end of the semester preceding admission. All credits to be transferred must be identified at the time of application for transfer. The University reserves the right to deny credit for course work taken by the student prior to admission if it is identified and presented after transfer.

Students who transfer from four-year institutions must complete a minimum of 30 semester credits at the University of Lowell to be eligible for a Lowell baccalaureate degree. The University will not reduce the minimum residency requirement of 60 semester credits for students who present 60 or more semester credits from a two-year college. This regulation applies both to students who transfer directly from two-year institutions and to students who transfer 60 or more semester credits from a two-year college to another four-year institution and subsequently transfer to the University of Lowell. The records of applicants who have completed associate degree programs or who have established matriculation at other accredited institutions of higher education and are eligible to return to such institutions for the semester in which they seek admission to the University are routinely processed by the office of admissions for regular transfer admission.

* No credit will be recognized for the grade of "P" unless the catalog of the transferring institution specifically states that "P" is equivalent to a final course grade of "C" (2.0 on a 4.0 scale).

Required Credentials for Transfer Applicants

It is the responsibility of students seeking transfer to the University for arranging with the institution in which their previous work was completed to forward to the office of admissions no later than May 1st for fall semester admission or November 15 for spring semester admission official transcripts of their completed courses and notations of all courses in progress.

Additionally, final transcripts of all completed courses must be forwarded to the office of admissions following the completion of previously designated courses in progress. Unless applicants have made special arrangements with the registrars of their previous institutions to telephone grades for previously designated courses in progress to the office of admissions, their application files will be designated as incomplete when they do not contain an official and final transcript. Transfer students whose records are incomplete on the first day of semester classes may be prohibited from attending courses and may be required to withdraw from the University.

An applicant who has attended one or more institutions must request each registrar to mail directly to the office of admissions a transcript of his or her record even though credits were not earned or credits are not presented for transfer. An applicant who has fewer than 30 semester credits of acceptable courses, with grades of "C" (2.0 on a 4.0 scale) or better must request that his or her high school record and College Entrance Examination Board test scores be sent to the office of admissions.

Evaluation of Transfer Credentials

A preliminary evaluation of course credits to be transferred to the University is made by the office of admissions at the time of application. Students seeking transfer should be aware that this evaluation by the office of admissions is preliminary in nature and that acceptance of transfer credit and assignment of a year of graduation or other status is subject to final review by the student's major department when the student is formally accepted for matriculation by one of the colleges of the University. Credit which is acceptable according to general University standards is not necessarily acceptable for specific programs. This is especially true when program transfer quotas have been imposed. The office of admissions will advise applicants when their admission to the University does not guarantee acceptance into their preferred professional programs. The applicability of grades received in transferred courses for the determination of the grade-point average of the student's major at the University of Lowell is determined by policies of each of the colleges.

University Restrictions Concerning Transfer Credit Recognition

Courses completed at non-public institutions which are not accredited by the major regional accrediting associations will not be credited to degree programs of the University. Nor will credit be granted for non college level courses, courses which are unacceptable to the transfer institution for its own associate or baccalaureate programs or which are completed within post-secondary school diploma programs. Non-credit "CEU" courses, adult-enrichment or refresher courses, and secondary school correspondence and home study courses also are not recognized for transfer credit. The University reserves the right to refuse recognition for courses which were taken more than ten years prior to the date when a student applies for transfer when, in the opinion of department chairpersons and program directors, the knowledge attained in such courses is deemed to be out of date and/or in need of verification. Competencies which a student has achieved through such courses, or by any other means, may be recognized for credit if verified by CLEP or department examinations.

College and Program Restrictions Concerning Transfer Credit

Many colleges and programs impose additional restrictions on the acceptability of transfer credit. The College of Health Professions and the College of Management Science have special regulations governing the acceptance of transfer credits for professional courses. Transfer applicants to these colleges should consult the dean of the college or the appropriate department chairperson concerning transfer credit for these courses. The College of Liberal Arts does not accept in transfer professional courses from any program or curriculum whatsoever, with the exception of courses credited to the degree program in the Administration of Criminal Justice. Students transferring to the College of Pure and Applied Science may transfer course credits in science and mathematics if these courses are equivalent to those specified by the curricula of the college. Prerequisites for courses in the major field within the College of Pure and Applied Science or courses which are prerequisites to admission to the college may not be credited to the minimum degree requirements in mathematics or the sciences.

As a general rule, courses of a professional nature from any curriculum are not accepted in transfer when a student seeks admission to a different curriculum or program at the University of Lowell. Transfer applicants should consult the appropriate dean or departments for current regulations. Additionally, transfer applicants who enter the University in one program, or as undeclared students, may find that certain credits will be deleted from the record when they seek internal transfer to another college or program.

Initial Review of Transfer Students for Compliance with University Retention Standards

For the purpose of determining academic standing, student records are reviewed each semester. Transfer students are initially evaluated for retention purposes at the end of the semester in which they have attempted their first 18 credits at the University unless they have been admitted with probationary status. Transfer students who have been dismissed from their last previously matriculated institution for academic reasons are initially admitted to the University on probation and are reviewed at the end of their probationary semester for compliance with probationary requirements.

Grade point averages for transfer students are computed solely on the basis of courses attempted at the University of Lowell. Grade point requirements are based on the total number of attempted course credits. This number includes course credits attempted at both the previous institution and the University of Lowell. For the table of grade point requirements for specific numbers of attempted course credits, refer to the section "Academic Policies: Determination of Academic Standing."

The Commonwealth Transfer Compact

The University of Lowell has affirmed its intention to maintain flexibility in the transfer of qualified students from community colleges of the Commonwealth of Massachusetts. For the implementation of this objective, the University of Lowell has subscribed to the Commonwealth Transfer Compact and applies to students who apply for admission under this compact the same policies which are applied to University of Lowell students who petition for intercollegiate transfer within the University.

All courses which have been accepted by the University from signatory community colleges of the Commonwealth Transfer Compact are listed on the student's transcript, and those courses which are not applicable to specific curriculum requirements are credited, whenever possible, as unrestricted elective courses. Since some curricula of the University do not provide for such unrestricted elective courses, or the number of transferred courses may exceed the number of unrestricted elective courses which are permitted within the specifications for minimum degree requirements, transferred courses which are not applicable to the specific requirements of a curriculum are not counted in the determination of the number of course credits completed until the semester of graduation. This procedure prevents the early imposition of a grade point requirement for retention which is in excess of that specified for the number of credits completed and applicable to the student's particular curriculum.

The revised Commonwealth Transfer Compact (1984), which focuses upon the Associate of Arts and Associate of Science degrees, provides a process to facilitate the transfer of collegiate credits and to ensure the appropriate recognition of academic progress earned by students at a community college who wish to continue their education at a public college or university.

1. General Requirements for Transfer under the Compact

   In order to meet the requirements of this agreement, a student must have completed an Associate of Arts degree or an Associate of Science degree which has been specifically designated by the Board of Regents as a transfer degree and must have achieved a grade point average of not less than 2.0 (in a 4.0 scale) at the community college awarding such degrees.

   By agreement, these degree programs consist of a minimum of 60 semester credits and a maximum of 66 semester credit of undergraduate college level study.

   Under this articulation agreement, students accepted for transfer to baccalaureate programs of the University who hold either an Associate of Arts degree or an Associate of Science degree which has been designated by the Board of Regents as a transfer degree may not be subject to greater general education or degree requirements than those which are in effect for University students who enrolled in such programs as freshmen. Except for those requirements which are specified by departments for the baccalaureate major, no special requirements may be imposed upon compact students.

   The University is not required to accept more than 66 semester credits for the baccalaureate degree and has the right to require two years of full time study at the upper division level and fulfillment of all requirements for the baccalaureate major.

   The University will accept the grade of "D" toward the baccalaureate degree and will grant "D" credit for the baccalaureate major if it does so for those students who enrolled in the baccalaureate program as freshmen.

Students who earn an associate degree at a community college, thereafter transfer to the University of Lowell, subsequently return to a community college and earn an Associate of Arts or Associate of Science transfer degree do not come under the protection of the transfer compact in the event that they again enroll at the University of Lowell. Nor does credit earned at a Massachusetts community college come under the protection of the transfer compact if a student has not completed the Associate of Arts or Associate of Science transfer degree prior to enrolling as a transfer student at the University.

Students who invoke the protection of the Commonwealth Transfer Compact may not establish simultaneous matriculation in a Massachusetts community college and the University. Students who complete associate degree requirements when registered as transfer students in baccalaureate programs of the University have attempted to establish such dual matriculation and either must relinquish protection of the compact or must forego baccalureate credit for all University of Lowell courses which have not been recognized by the compact institution for the associate degree program.

2. Community College Transfer Degrees

All college level courses taken in the community colleges will be applied first toward the fulfillment of the general education requirements of the receiving institution. The remaining course credits earned at the college level at the community colleges, provided that they are applicable to the student's degree program in the University, will be assigned toward major requirements and/or graduation requirements.

a. The Associate of Arts Degree:

The basic community college program for the Associate of Arts degree includes a minimum of 33 semester credits in general education. Each institution will require students to complete the minimum semester credits specified in each of the following:

English Composition/Writing	6 s.c.
Behavioral and Social Sciences	9 s.c.
Humanities and Fine Arts	9 s.c.
Mathematics and Natural Science	9 s.c.

Completion of the above general education requirements will satisfy the composition and area distribution requirements of the University of Lowell core curriculum, but the human values requirement of the University core curriculum, is not necessarily satisfied by completion of the general education requirements of the Associate of Arts degree.

b. The Associate of Science Transfer Degree:

The Associate of Science transfer degree emphasizes scientific, mathematical, and technical competencies and therefore requires special concentration in these areas.

Each community college is encouraged to develop a general education component for its Associate of Science degree which is appropriate for its particular discipline. At a minimum, the Associate of Science transfer degree must include 21 semester credits of general education.

Completion of the general education requirement of this degree program does NOT complete the area distribution requirement of the University of Lowell core curriculum; nor is the human values requirement of the University core curriculum necessarily satisfied by completion of above general education requirements of the Associate of Science degree.

3. Other Associate Degrees and Certificates

Massachusetts public community colleges may award other associate degrees and certificates with a primary objective other than student transfer to a four-year institution. Course credits from such programs which are presented for transfer will be evaluated by the four-year institution according to their applicability to general education requirements, to unrestricted elective courses, and to requirements in the student's major field. Transfer students are advised, however, that in most cases course credits earned in these programs, other than general education credits, will not be applicable to degree programs at the University of Lowell.

APPLICANTS FOR ADDITIONAL BACCALAUREATE DEGREE

A student who has earned a baccalaureate degree at the University of Lowell or at another accredited baccalaureate institution may be admitted to the University to pursue an additional baccalaureate degree subject to the following requirements:

1) the nomenclature of the additional degree to be pursued must be distinctly different from the previously conferred degree,*

2) the major field of the previous degree must be clearly distinct from that of the additional degree,

3) the work for the additional degree must consist of not less than two semesters of full-time residence,

4) the final 30 credits presented for the additional degree must be in addition to and independent of any previous baccalaureate, and

5) a minimum of 15 credits must be taken at the University in the major field which is presented for the additional degree.

Candidates for the additional baccalaureate degree who have completed initial baccalaureate degrees at other institutions must complete an uninterrupted year of full-time residence at Lowell earning a minimum of 30 credits.

Candidates for the additional baccalaureate must fulfill all curriculum requirements for the additional degree (including courses presented from previous programs and courses completed in fulfillment of the final 30 credit requirements) and must comply with any special college regulation concerning completion at the University of major field requirements. Students who are candidates for an additional baccalaureate degree may be eligible for major field honors but are not eligible for University honors unless they have completed 60 credits at the University following their admission as candidates for the additional baccalaureate degree.

Application for admission to the University as a candidate for an additional baccalaureate degree is made through the office of admissions. Prior to admission to the University as candidates for additional baccalaureate degrees, applicants must be approved by the college in which they plan to matriculate and the department in which they intend to major.

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* e.g., Bachelor of Arts, Bachelor of Science, Bachelor of Music, Bachelor of Science in Engineering, Bachelor of Science in Business Administration, etc.

Retention standards for candidates for additional baccalaureate degrees are based upon the grade-point averages for achieving satisfactory standing which are specified for the several levels of course credits completed. Grade-point averages are computed solely on the basis of qualitatively graded courses which have been completed at the University for the additional baccalaureate degree. The number of course credits completed include those which have been applied from previous baccalaureate programs. (Cf. "Academic Policies: Determination of Academic Standing").

Probationary Admission Policy for Transfer Students

Students who have been dismissed for academic or disciplinary reasons from their last previously attended institution may apply for initial admission to the University of Lowell only as probationary students.* The respective deadlines for filing such applications with the office of admissions are April 1 (for fall semester acceptance) and November 1 (for spring semester acceptance).

In addition to the filing of the standard application forms with the office of admissions, the applicant for initial admission as a probationary student must comply with the following:

1) arrange with all previously attended institutions of higher education to forward copies of all academic records to the office of admissions,
2) submit a written statement which both explains the nature of the previous dismissal and evidences support for his or her application to the University, and
3) file written authorization with the office of admissions for release to the University of Lowell of all documentation concerning his/her dismissal from a previously attended institution in the event that such dismissal was disciplinary in nature.

All materials filed with the office of admission will be forwarded to the academic standards committee of the college within the University to which the individual has applied. Prior to rendering a decision, the academic standards committee may require an interview with the applicant. After reviewing all previous academic records, the applicant's letter, and other pertinent documentation from the office of admissions, the committee shall forward its recommendation to the Director of Admissions. If the decision is to accept the applicant as a probationary student, the committee will further establish the requirements which the applicant must satisfy as a condition of probation. These shall include, at a minimum, the attainment of a cumulative average of 2.00 for the probationary semester.

The decision rendered by the academic standards committee shall be final as it relates to the applicant's admission to programs within the college to which the student has applied and also as it relates to the then current admission cycle. The evaluation of applicant credentials and the granting of transfer credit are accomplished subsequent to admission and according to program policies concerning transfer credits.

* The above transfer application process may not be invoked by students who have been suspended from the University of Lowell (Cf. "Readmission Procedures for Previously Matriculated Students"). Nor may this process be invoked by students who have been expelled from the University of Lowell. Regardless of any degree program subsequently completed at another institution, a student who has been expelled from the University may not be readmitted for undergraduate study.

APPLICATION PROCEDURES FOR NON-MATRICULATING STUDENTS

Admission as a non-matriculating student is granted only within provisions which govern the non-degree programs cited below.

Applicants for admission as non-matriculating students are required to file admission applications and to submit such credentials as are specified for their proposed non-degree programs. Should a non-matriculating student subsequently apply to the University for admission as a matriculating sutdent, all course work completed as a special student will be evaluated by the college in which he or she is accepted.

A non-matriculated student may be readmitted to a non-degree program subject to the following conditions: (1) the student has satisfactorily completed his or her previously attempted courses, (2) the original condition under which he or she initiated non-matriculating studies permits continued enrollment, and (3) commitments of the University to matriculating students permit enrollment of non-matriculating students.

Programs for Talented High School Seniors

Under certain specified conditions, talented high school seniors are permitted to enroll in the University as non-matriculating students. To qualify for such studies, high-school seniors must be recommended by their principals as students who are sufficiently mature to complete their proposed courses of study. Each case of a non-matriculating high-school senior is considered individually on its own merits, and the office of admissions and the departments offering the courses desired by the student must concur with the high-school principal's recommendation. Application for admission under the provisions of policies of non-matriculating high-school seniors should be submitted to the office of admissions according to the schedule established specifically for this purpose. Grades and course credits will be recorded on the permanent record of the student for all attempted course work in accordance with the grading system of the University and will appear on any official transcript issued to or for the student. In the event that non-matriculated high-school seniors subsequently are granted matriculation status, their completed courses ("D" or better) will be credited to degree programs in accordance with regulations of the college to which they are admitted.

Programs for Students Matriculated at Other Colleges and Universities (Visting Students)

Students who are matriculants for degrees at associate or baccalaureate institutions may be admitted to the University to pursue specifically authorized courses. Such students are admitted to the University on a semester-by-semester basis and must secure prior approval for University courses from appropriate authorities at institutions where their degrees will be granted. Permission to enroll in courses of the University will not be granted to students without a letter from an appropriate officer of the institution in which they are matriculating which certifies that they are candidates for a degree and are in good academic standing. Courses of a professional nature may not be elected by non-matriculating students of the University unless specifically authorized by the appropriate college dean.

Day Programs for Students Matriculating for Continuing Education Degrees from the University

Students who have established matriculation for University of Lowell continuing education degrees at either the associate or baccalaureate levels may be permitted to pursue specifically authorized day courses. Such students must secure the written approval of their program coordinators for all projected courses prior to filing an application with the office of admissions. Full notation of approved courses (including those which have been failed) is made upon the permanent record of continuing education students.

Programs for University Employees

University employees who are high school graduates or who possess certificates of high school equivalency may apply for admission as non-matriculating students. Admission is extended to employees as non-matriculating students on a semester-by-semester basis and solely for courses designated at the time of application. Employees who wish to matriculate for a baccalaureate degree should apply for admission to the Second Chance program. Participation in this program is subject to employee obligations and special policies of the Board of Trustees.

Non-Matriculating Programs for Students Holding Baccalaureate Degrees

An individual who holds a baccalaureate degree and who wishes to pursue a limited non-degree program (up to a maximum of 15 credits) may be admitted full or part time to the University as a non-matriculating student. Such admission requires the approval of each of the departments in which courses are contemplated. University of Lowell graduates should indicate their dates of graduation on their application forms. Other applicants must request the registrars of the institutions in which their degrees were conferred to mail transcripts of their baccalaureate records directly to the office of admissions and are warned that permission to enroll in courses will be denied if transcripts have not been received prior to course registration. A student who holds a baccalaureate degree and who wishes to pursue a second baccalaureate should investigate the appropriateness of both degree and non-degree programs of the Graduate School before applying for such status.

READMISSION PROCEDURES FOR PREVIOUSLY ENROLLED STUDENTS OF THE UNIVERSITY OF LOWELL (NON-GRADUATES)

The University does not grant leaves of absence to students who wish to interrupt their baccalaureate studies. Accordingly, students who have withdrawn from the University and who seek readmission must file an application for readmission with the office of admissions. When resources of a college or program render it necessary to establish limitations upon enrollments, the office of admissions will establish a waiting list of applicants for transfer and reinstatement. Differential admissions criteria above and beyond minimum program requirements may be applied to these individuals to ensure the admission and readmission of the most qualified applicants for the limited openings.

Upper division students in the College of Health Professions who have withdrawn must make individual arrangements with appropriate chairpersons to reserve their spaces in courses for the semester of the anticipated return to the University. Unless such special arrangements have been made, reinstatement by the office of admissions cannot ensure full resumption of a student's course of study.

In the event that readmission applicants wish to change their programs and/or to seek readmission to the University in a college other than that which they previously attended, their reinstatment must be approved by the chairperson of the program to which they seek admission and the appropriate college dean. If program enrollments permit, approval for such readmission will be granted to students who satisfy all program admission requirements. Individuals who seek readmission to the University in a college other than that which they previously attended will be subject to reevaluation procedures which are specified for enrolled students who seek an intercollegiate transfer. (Cf., policies governing intercollegiate transfers which appear elsewhere in this publication under the heading "Academic Policies: Change of Major with Intercollegiate Transfer.") Individuals who apply for intercollegiate transfers must submit their applications no later than November 1 for spring semester reinstatment and April 1st for fall semester reinstatment.

Unqualified Reinstatement

Individuals who were students in satisfactory academic standing prior to their withdrawal *and who have not been absent from the University for more than one semester* are automatically reinstated to the programs in which they were previously enrolled and are subject to curriculum requirements which are in effect for the classes to which they previously belonged. Application for readmission must be filed with the office of admissions.

Qualified Reinstatement

Students who have been absent from the University for two or more continuous semesters are subject to the rules and regulations of the University which are in effect at the time of their readmission rather than at the time of their original admission. If program enrollments permit, individuals who were students in satisfactory academic standing prior to their withdrawal ordinarily are reinstated to the programs in which they were previously enrolled. However, during an individual's absence some programs may have established higher entrance and retention requirements and he or she may be denied reinstatement for failure to satisfy these requirements.

Individuals are not automatically reinstated to the programs in which they were previously enrolled when they have been absent from the University for periods exceeding ten years. Course work which has been completed prior to ten years of the date of readmission is generally recognized only through those examination procedures described in the policy statements for course equivalency. Such course work may also be evaluated on an individual basis by the academic standards committee of the college in which an applicant desires to reestablish his or her matriculation. Students who wish to have such course work evaluated by the committee must present their cases in writing to the committee no later than November 1st for spring semester readmission and April 1st for fall semester readmission. Such students who wish to reestablish their matriculation on a part-time basis should consider the Second Chance program.

A student who has been expelled from the University may not be readmitted for undergraduate study.

Probationary Readmission

Individuals who have been suspended or dismissed from the University for unsatisfactory academic standing may apply for readmission only as specified below. Probationary studies will be authorized only during the fall and spring semesters and only in day classes. Applications for probationary readmission to all programs except continuing education should be addressed to the appropriate college academic standards committee and must be filed with the office of admissions by April 1st for a readmission decision during the spring semester and by November 1st for a readmission decision during the fall semester. The decision to readmit an academically suspended or dismissed student rests with the appropriate committee and not with the office of admissions. In determining the requirements for probation, the committee is required to prescribe a sufficient number of courses for each student which shall make the achievement of satisfactory academic standing reasonably possible during the probationary period.

Readmission for Academically Suspended Students

A student who has been academically suspended from the University is entitled to apply for readmission as a full-time probationary student but may not initiate his or her probationary studies before an absence from the University of one semester.* (Cf. Academic Probation, pp 104-105 for specific probationary requirements.) Except as prohibited by the academic policies of professional colleges, suspended students may petition for readmission to the University with probationary status as follows:

1. all suspended students may petition for readmission to the college in which they were previously enrolled and may request reenrollment in the former major or readmission with a change of major;
2. freshmen students and sophomore students who have not attempted more than 45 credits or who have not completed more than three full-time semesters also may petition for simultaneous intercollegiate transfer and probationary admission to a new program. *Students who have attempted 45 credits or three full-time semesters are not eligible for intercollegiate transfer at the time of probationary readmission.*

Students who fail to achieve satisfactory academic standing and are not granted extensions of their probations by the appropriate college academic standards committee and students who are granted such extensions and fail to achieve satisfactory academic standing are dismissed from the university. Such students are subsequently barred from attending both day and evening courses.

Readmission for Academically Dismissed Students

Freshman and sophomore students who have been academically dismissed may qualify for readmission to the university as follows: 1) under provision of the Massachusetts Transfer Compact after completion of an associate degree at a Massachusetts community college; and 2) after a lapse of two years during which time they must have demonstrated their academic capacity and seriousness of purpose by obtaining an associate degree at a regionally accredited institution of higher education.

* The Vice President for Academic Affairs may waive the mandated period of absence for foreign residents and for reasons of extraordinary circumstances of personal hardship.

Students of junior or senior standing at the time of dismissal may reapply for probationary readmission to the university after an absence of at least two years, during which time they must have developed a record of successful work or professional experience which demonstrates their seriousness of purpose. Additionally, each student's grade-point average at the time of dismissal must be sufficiently high to afford a reasonable chance of successful completion of probationary periods or degree requirements. Although readmission under this policy normally requires a commitment to full-time probationary studies, students who have less than 12 credits to complete for degrees and who can comply with qualitative graduation standards by less than full-time studies may be readmitted for a probationary semester on a less than full-time basis.

ADVANCED PLACEMENT POLICIES FOR BACCALAUREATE APPLICANTS

Students entering the University as freshmen or as transfer students may elect to challenge courses through established procedures cited below. University departments reserve the right to refuse the granting of credit for those examinations which are presented by a student for his or her major(s). Equivalency credit is granted for laboratory components of science courses only through examinations of University departments. Accordingly, science credits which are granted through the College Level Examination Program and Advanced Placement Examinations of the College Entrance Examination Board do not waive any specified laboratory requirement, including those of the University core curriculum.

College Level Examination Program: General Examinations

Entering freshmen may be granted University credit for general examinations if they have achieved minimum designated scores. General examination credit is granted at the time of admission only. Students who change major fields subsequent to receiving credit for general examinations are advised that previously granted credits are automatically nullified if their new majors are in an area in which general examination credit has been granted.

CLEP Examinations	Maximum Semester Credits Authorized	Required Scores + +
English Composition*	3	500
Mathematics +	6	500
Natural Sciences +	6	500
Social Sciences#	6	500
Humanities**	6	500

+ + Cited scores are for April 1986 CLEP scales. Scores of 600 are required for earlier CLEP scales.

* A score of "500" satisfies the requirements for College Writing I.

+ Credit may be granted only to students who matriculate for degrees in the College of Liberal Arts and the College of Music. Natural science credit granted does not satisfy the specific laboratory course requirement of the revised University Core Requirements.

Credit May be granted only to students who matriculate for degrees in the College of Liberal Arts, the College of Management Science, and the College of Music.

** Credit will not be granted for a general examination in an area which is cognate with a student's major. For example, credit for the general humanities examination will not be granted to students who major in art, English, languages, music, philosophy, or other humanities areas.

College Level Examination Program: Subject Examinations

Entering freshmen and transfer students may be granted university credit for subject examinations of the College Level Examination Program when they have achieved scores which are on or above the "C" grade level. A complete listing of subject examinations of CLEP for which the University grants credits may be found elsewhere in this publication under the heading "Academic Policies: Course Equivalency Examinations."

Advanced Placement Examinations of the College Entrance Examination Board

Entering freshmen who have demonstrated college level proficiency through advanced placement examinations of the College Entrance Examination Board may be granted University credit for scores of "5", "4", and "3". Credit will not be given for scores of "2" or "1". The following is a listing of advanced placement examinations for which the University grants course credit:

AP Examination	Course Equivalent		Credit
American History	43-111,112	(U.S. History)	6
Biology	83-101,102	(Life Science I & II)	6
Chemistry	84-121,122	(Chemistry I & II)	6
Classics-Vergil	56-303	(Selected Latin Authors)	3
Classics-Latin Lyric	56-303	(Selected Latin Authors)	3
English*	42-101	(College Writing I)	3
European History	43-105,106	(Western Civilization,The Modern World)	6
French Language	50-246,248	(Advanced Conversation & Composition)	6
French Literature	50-261,262	(Literature of Ideas & Selected Writings)	6
German Literature	51-491	(German Literature)	6
Mathematics: Calculus AB	92-133,134	(Calculus I & II)	8
Mathematics: Calculus BC	92-133,134	(Calculus I & II)	8
Music	74-161	(Music of Western Civilization)	3
Physics B	95-103,104	(General Physics I & II)	6
Physics C—Mechanics	95-141	(Physics I)	3
Physics C—Electricity & Magnetism	95-245	(Physics III)	3
Spanish Literature	54-302,303	(Introduction to Spanish & Latin American Lit.)	6

* An additional 3 credits will be granted to students for 42-102, College Writing II, upon successful completion of the exemption examination administered by the Department of English.

Foreign Language Achievement Tests of the College Entrance Examination Board

University credit is granted upon the recommendation of the Department of Languages to entering freshmen who have demonstrated satisfactory language competency through the Language Achievement Tests of the College Entrance Examination Board. University credit on the intermediate course level will be given to students achieving scores of "550" or better. Such credit will satisfy any language proficiency requirement.

Foreign Language Achievement Tests Administered by the Department of Languages

University credit is granted to entering freshmen and transfer students who have demonstrated satisfactory language competency through reading examinations in foreign languages which have been administered by the Department of Languages. College credit on the intermediate level will be given to students achieving satisfactory scores in tests of foreign languages which are offered by the University of Lowell. Such credit will satisfy any language proficiency requirement.

Course Credit Limits Through Advanced Placement With Credit

The maximum number of credits which may be granted to an entering student through advanced placement procedures, including departmental equivalency examinations and CLEP examinations, is 30 semester credits. Under no circumstances will duplicate examination credit be granted to students who present formal course work for transfer. Nor will examination credit be granted to transferring students for the purposes of reducing either the major field residency requirement of 15 credits or the general residency requirement of 30 credits in University day courses.

HEALTH CERTIFICATION REQUIREMENTS FOR ADMISSION

All students who are admitted to the University (both matriculating and non-matriculating) are required to present evidence of satisfactory physical and mental health to the health service office. Each admitted student will receive a health report form which must be completed and filed with the health service office. Upon the advice of a health service physician, the admission, readmission or continuing registration of a student may be denied until the student is cleared by the health service. Military personnel may have their student health report forms completed by a base physician.

All new and readmitted students are required to present evidence of freedom from tuberculosis by means of clinical testing or chest X-ray and prior to beginning classes must file evidence of the following with the health service:

1) Recent Mantoux tuberculin test (Tine test not acceptable);
2) Physical examination and health history questionnaire;
3) Record of childhood illness or immunization for measles, mumps, and polio;
4) Record of rubella immunization or rubella titer; and
5) Medical release form if under 18 years of age.

FINANCIAL INFORMATION

The information provided below covers all matters relating to University expenses (including both state and university policies governing fees, residency and non-residency tuition rates, payment schedules, tuition waivers, the New England regional program, and financial requirements for foreign students) and to financial aid programs (including V.A. benefits and scholarship, loan, and work study programs).

UNIVERSITY EXPENSES

University related costs (tuition, fees, housing, board, books, and special uniform expenses) for Massachusetts citizens who reside on campus are approximately $4,500. Similar expenses for out of state students are $6,500. Additional costs for which the student should plan in estimating his or her total expenses include clothing, transportation, and entertainment. Expenditures for books and instructional supplies vary considerably, depending upon the student's major subject, but a conservative estimate for such expenditures is $900. Official University charges noted below and in the following sections concerning Food Services and Student Housing were in effect at the beginning of the 1986-87 academic year and are subject to change without prior notice by the Board of Regents of Higher Education or the Board of Trustees of the University of Lowell.

University Charges

University charges include tuition, mandatory fees, and applicable room and meal plan costs.

Tuition

Full-time Tuition (residents of Massachusetts)	yr.	$1080.00
Full-time Tuition (non-residents of Massachusetts)	yr.	3636.00
Special student Tuition (residents of Massachusetts)*	cr.	50.00
Special student Tuition (non-residents of Massachusetts)*	cr.	145.50

* Special student tuition fees are not applicable to full-time students who are granted "reduced load status."

University Fees

Academic Service Fee	sem.(max.)	45.50
Application Fee (residents of Massachusetts)		10.00
Application Fee (non-residents of Massachusetts)		25.00
Applied Music Fee	sem.	164.00
Athletic Fee	yr.	90.00
Audit Fee	cr.	30.00
Capital Equipment Fee: College of Engineering and College of Pure & Applied Science	sem.	54.50
Change of Course Fee (per course change transaction)		5.50
Supervision Fee: College of Music	course	12.50
Clinical Supervision and Capital Equipment Fee: College of Health Professions	sem.	27.50
Commencement Fee, (seniors, one time only)		47.00
International Student Services Fee (one time only)		27.50
Laboratory Fee	lab.	27.50
Late Registration Fee		21.00

New Student Fee (one time only)			5.00
Orientation Fee (Freshman, transfer, readmitted students)			50.00
Recreation Service Fee		yr.	15.50
Student Activity Fee	1st sem. 47.10)		
	2nd sem. 23.60)	yr.	(70.70)
Student Union Fee		yr.	50.00
Transcript Fee (after three transcripts)		ea.	1.00

Room and Meal Plan Charges

Dormitory Charge (Undergraduate)	yr.	1393.00
Dormitory Damage Deposit Fee		50.00
Meal plans		
Plan A	yr.	1586.00
Plan B	yr.	1542.00
Plan C	yr.	1474.00
Plan D	yr.	1230.00

Insurance Charges

Accident Insurance (Covered for full-time students by Activity Fee)	
Optional Major Medical Insurance	
Single Students	95.00
Student and Spouse	225.00
Student, Spouse, and Dependent Children	360.00
Mandatory Insurance	
International Students	165.00

Explanation of University Charges

Tuition Rates

The Board of Regents establishes tuition rates on the basis of official state residency. Eligibility for in-state tuition rates is determined by regulations governing Massachusetts residency and the New England Regional Student Program, the details of which are provided below.

University Fees

Academic Service Fee

This fee is established to support the delivery of academic services to the student body by the computer and library services. Expenditures are made for the maintenance and repair of equipment, the cost of expendable supplies, etc.

Application Fee

State law requires institutions of public higher education to collect specified application fees. These fees are not refundable and are not applicable to tuition.

Applied Music Fee

This fee is charged to undergraduate students who take applied music courses and, in part, covers the cost of individual lessons and special ensemble instruction.

Athletic Fee

This fee is for the support of varsity athletics, intramural athletics, and their associated expenses.

Audit Fee

This fee, levied for part-time students only, is determined by the number of contact hours for which an audited course is scheduled. Fees for courses which include both lecture and laboratory hours are levied for lecture hours only since laboratory hours may not be audited.

Capital Equipment Fee

Charged to engineering, science and health professions to defray costs of laboratory equipment.

Change of Course Fee

This fee is assessed when students initiate a course change; a fee of $5.50 is charged for each change, that is for each add, each drop, each section change. No fee is charged for a change in a student program which is the result of University action. The appropriate college dean may waive the fee in those cases for which, in his or her opinion, sufficient and/or compelling reasons exist.

Clinical Supervision Fee

This fee is charged those students who are placed in clinical agencies, including schools, to defray the costs of supervision by University faculty and those expenses which are incurred by personnel of cooperating agencies and schools. The fee is collected for each clinical experience for which the student has contracted.

Commencement Fee

This charge is assessed in September of the student's senior year and helps to defray the costs of graduation exercises. Students who desire to graduate "in absentia" may not be granted a waiver of this fee.

International Student Services Fee

This fee is charged to international students at the time of their entry to the University to cover the costs of processing records.

Laboratory Fee

Most science courses and some criminal justice, music, nursing, physical therapy, psychology, and art studio courses require the payment of this special fee.

Late Registration Fee

Students who fail to register prior to the late registration period or to make payment of their charges by the date specified on their semester bills are required to pay this fee.

New Student Fee

A one time fee to defray the costs of processing the records of new students, both freshmen and transfer students.

Orientation Fee

Charged to defray some costs, such as meals, counseling, student guides, printed materials, and other activities during the orientation period for new students.

Recreation Service Fee

These funds are used to support the development of recreational activities, services and facilities.

Student Activity Fee

This fee, required of full-time students only, supports an extensive and varied range of athletic, cultural, and social activities for students. In addition, payment entitles each student to admission to many campus events and includes a subscription to the campus newspaper, the yearbook, and accident insurance.

Student Union Fee

Funds derived from this fee, which is levied upon full-time students only, are used to support the Student Union North.

Transcript Fee

Students are issued three transcripts of their permanent academic record cards without charge. A fee of $1.00 is charged for the fourth transcript and for each additional transcript thereafter.

Dormitory Charges

Room Rent and Reservation Deposit

The room rental charge is payable in two installments. Payment for the first semester is due on or before August 15, or in the case of late acceptance, within fourteen days of billing. Second semester rent is due and payable as noted on the spring semester invoice. Each student must submit a $100.00 room guarantee deposit at the time the residence hall reservation and contract is submitted to the business office. The deposit reserves the room until occupancy and is applied to the second semester room rental. A student who subsequently cancels his or her residence hall contract forfeits this deposit.

Damage Deposit Requirement

All dormitory students must have on deposit a total of $50.00 with the business office at the beginning of each academic year. This sum will be held in escrow pending assessments of residence hall damages and will be refunded upon termination of residence hall occupancy when such damages have not been assessed. Any interest accrued from the damage deposit will be held by the office of the dean of students in a trust fund, which will be used for the general improvement of residence hall life. In the event that assessed damages are in excess of the deposit, an appropriate bill will be rendered.

Energy Surcharge

Assessed on dormitory students to assist in defraying the costs of heat, light, hot water. Included in dormitory charge.

Insurance Charges

Student accident insurance coverage for the academic year is obligatory and is included in the student activities fee. Medical and surgical insurance is available at a nominal fee at the time of registration in September. This additional coverage is required for international students and is optional for non-international students. When injury shall require treatment by a legally qualified physician or surgeon, dental treatment to sound, natural teeth, confinement within a hospital, use of ambulance or employment of a graduate or licensed nurse, the accident insurance coverage will pay the expense actually incurred by the student within 52 weeks after the date of the accident for such treatment, hospital confinement, ambulance and nurse expense up to an aggregate amount not to exceed $1,000.00. Additional coverage for sickness, major medical benefits and special coverage for mental and nervous disorders and alcoholism is provided by the optional insurance plan. A family plan for married students is also available with options for coverage of spouses only or spouses and dependent children. Details concerning coverage provided by the student medical plan may be secured from the office of the Dean of Students, Cumnock Hall (North Campus). For policies concerning compulsory reporting of illness or accident, see Health Services.

PAYMENT, REFUND, AND WAIVER POLICIES

Policies governing tuition, fees, housing, and meal plans are set by state and university boards, agencies, and authorities. Policies concerning University tuition and fees are determined by the Board of Trustees. Policies concerning room and meal plans are determined by the University of Lowell Building Authority and are established by the Board of Trustees. Policies governing tuition waivers are established either by the General Court or the Board of Regents of Higher Education.

Payment of Bills

Students will be permitted to attend classes and to utilize University facilities only after they have cleared their financial obligations (including the payment of library fines) or have made satisfactory arrangements for payment. All bills are payable in advance by check or money order and are due as specified on billing statements. Checks or money orders for payment of fees and tuition must be made payable to the University of Lowell. Checks for the meal fee must be made payable to the University of Lowell Cafeteria Account. A student in debt to the University at the end of any semester or summer session for fees or other charges is not permitted to register again at the University until his or her indebtedness has been discharged. Such a student who has been preregistered shall have his or her registration cancelled without further notice if payment of previous indebtedness has not been made one month prior to the beginning of classes for the following semester. Grade reports of non-matriculating students will not be released unless all indebtedness has been discharged.

Should it be necessary to utilize the services of a collection agency for overdue student accounts, the student will be liable for any service charges incurred.

Refund Policy

A full-time student who withdraws from the University before the beginning of the fifth week will be granted a pro-rata refund of tuition upon application to the bursar. The date of official academic withdrawal as recorded by the office of the registrar is the primary basis of any claim for tuition refund but such refund also may be authorized for documented reasons of an extraordinary nature which are acceptable to the bursar. A student who makes an advance payment and then for any reason does not attend any part of the next semester or term at the University and who so notifies the office of the registrar on or before the first class day of the semester will be given a full refund of tuition and fees. The special application fee is not refundable. Refunds for tuition charges are granted to full-time students (including applicants for full-time status) in accordance with the following schedule:

Before the beginning of the second week	80% refund
From the second week but before the third week	60% refund
From the third week but before the fourth week	40% refund
From the fourth week but before the fifth week	20% refund
From the fifth week on	NO REFUND

Notification of cancellation of a dormitory contract must be received at the housing office, in writing, no later than the first business day of August for the Fall semester and the first business day of January for the Spring semester. A cancellation of a dormitory contract after the aforementioned dates will result in the student being reponsible for 50% of that semester's room charge, except in extenuating circumstances subject to the approval of the Vice President for Student Affairs and to the availability of an eligible replacement.

Refund of housing fees are granted in accordance with the following schedule:

Prior to first business day of August/January	100% refund
Before the third week of classes	50% refund
From the third week but before the fourth week of classes	40% refund
From the fourth week but before the fifth week of classes	20% refund
From the fifth week of classes on	NO REFUND

All housing cancellations are subject to a loss of the $100.00 non-refundable deposit.

Tuition Waivers

Tuition waivers are granted as specified by Massachusetts law to senior citizens. Waivers also are granted for categories of talented students as specified by policies of the Board of Regents for Higher Education.

Senior Citizens

Citizens of Massachusetts who are age 60 and over (senior citizens) are entitled to free tuition at the University on a space available basis. Applicable fees, costs of instructional materials (books, etc.), and tuition for short-term intensive workshops or seminars are not covered by this waiver. Senior citizens who are admitted as matriculating students must satisfy established admission requirements for programs or must qualify for admission to the University through the Second Chance Program.

Talented Students

Tuition waivers are granted to students who bring special academic, artistic, and athletic talents to the University. Awards may be for partial or for total tuition and are extendable for eight semesters of full time attendance for students having satisfactory academic records. Although not limited to Massachusetts residents, tuition awards are intended primarily for in-state students.

Applicants who believe that they have special academic, artistic, and/or athletic talents may apply directly to the director of admission for consideration or they may request secondary school principals and guidance counsellors to recommend them. The University encourages high school principals and guidance counsellors to call the attention of the director of admissions to an application which has been filed by a student whom they know to possess an exceptional talent. Tuition award recipients are identified by college deans and the athletic director from a list of potential recipients who have been identified by the director of admissions. Awards are made by the vice presidents for academic affairs and student affairs.

Veterans Benefits

The Veterans Administration has approved the University of Lowell for undergraduate study. Veterans must present a certificate of eligibility available from the Veterans Administration, Kennedy Building, Government Center, Boston, Massachusetts. Upon receipt of this certificate, the University will notify the Veterans Administration to initiate monthly payments to the student. Veterans who are registered in 12 or more semester credits are paid for full-time training; for 9-11 semester credits, three-quarter time training; and for 6-8 semester credits, half-time training.

A citizen of Massachusetts who is defined as a "Vietnam Veteran" and whose service is creditable to the Commonwealth may be issued a certificate of tuition exemption if he/she is enrolled in the University as a full-time student. Certificates must be renewed annually prior to the beginning of each academic year, are in effect only during such time as the student remains in good standing at the University, are limited to a period of study which may not exceed four years, and are issued during an eight-year period from the date of discharge or release from active service. In order to receive a certificate of tuition exemption, an eligible veteran must present his discharge papers at the Office of the Adjutant General, State House, Boston Massachusetts, and must provide the University Registrar with a certificate of eligibility. A veteran who is entering the University for the first time is required to pay the application and acceptance fees within the period designated on the application form for admission. The acceptance fee of $50.00 is refundable, upon request, after the certificate of tuition exemption has been issued by the office of the registrar. The application fee of $10.00 is not refundable. Tuition exemptions do not cover fees of the University.

Inquiries directed to the University concerning veterans affairs should be addressed to the Registrar, University of Lowell, Lowell, Massachusetts 01854.

MASSACHUSETTS RESIDENCY

The following regulations of the Commonwealth apply for tuition purposes to the classification of students at the University of Lowell as Massachusetts or non-Massachusetts residents.

Definitions

1) "Academic period"- A term or semester in an academic year or a summer session, as prescribed by the Board of Trustees or under their authority.

2) "Continuous attendance"- Enrollment at the University for the normal academic year in each calendar year, or the appropriate portion or portions of such academic year as prescribed by the Board of Trustees or under their authority.

3) "Domicile"- A person's true, fixed, and permanent home and place of habitation where he or she intends to remain permanently or for an indefinite time.

4) "Emancipated person"- A person a) who has attained the age of 18 years, or b) if under 18 years of age, whose parents have entirely surrendered the right to the care, custody, and earnings of such person and who no longer are under any legal obligation to support or maintain such person, or c) a person who has no parent. If none of the aforesaid definitions apply, said person shall be deemed an "unemancipated person".

5) "Parent"- With respect to a person (in the case of an adopted person, inserting the adjective "adoptive" before the words "mother" or "father" wherever used):

   a) the person's father;

   b) if the person's father dies, either the legal guardian or if no legal guardian is appointed, the person's mother;

   c) if neither the father nor mother is living and no legal guardian is appointed, the person who then stands in loco parentis to the person;

   d) if the father and mother are divorced, separated, or unmarried and legal custody has not been awarded, the father or the mother, as the case may be, with whom the person lives or, if he lives with neither and the father is living, the father.

6) "Residence"- A place of habitation.

Rules for Determination of Domicile

1) Domicile is not acquired by mere physical presence in Massachusetts while the person is carrying on a course of study at the University or while the person is engaged in employment for a specified term unless Massachusetts is otherwise the domicile of the person.

2) Domicile at birth may be changed thereafter, by action of the parent in the case of an unemancipated person or by action of the person himself in the case of an emancipated person.

3) A person claiming Massachusetts as his domicile shall furnish evidence to support such claim. The burden of proof in all cases is upon the person making the claim. The following shall be of probative value, although not necessarily conclusive, in support of a claim of domicile within Massachusetts:

   a) Birth certificate;
   b) Motor vehicle registration and/or operator's license;
   c) Voting or registration for voting;
   d) Certified copies of federal and state income tax returns;
   e) Property ownership;
   f) Continuous physical presence in Massachusetts during periods when not enrolled as a student;
   g) Permanent employment in a position not normally filled by a student;
   h) Reliance on Massachusetts sources for financial support;
   i) Former domicile in Massachusetts and maintenance of significant connections therein while absent;
   j) Domicile of parent within Massachusetts.

Evidence submitted in support of an assertion of domicile or of parental relationship shall be in such form as the President of the University or his designee may require. Copies of official records or documents shall be authenticated by a proper officer. Assertions of fact made other than by an authenticated copy of an official record shall be certified as to accuracy and completeness by the person submitting the same.

Proof of Parental Relationship

A person asserting that he or she is an emancipated person shall furnish evidence to support such assertion. Such evidence may include:

a) Birth ceritficate or any other legal document that shows place and date of birth;
b) Legal guardianship papers—court appointment and termination must be submitted;
c) Statements of the person, his parent(s), guardian(s), or others certifying no financial support;
d) Certified copies of federal and state income tax returns filed by the person and his or her parent(s);
e) Where none of the foregoing can be provided, an affidavit of the emancipated person in explanation thereof and stating fully the grounds supporting the claim of emancipation.

Rules for Classification

1) Every emancipated person applying for admission to the University who has maintained a residence in Massachusetts for a period of not less than twelve continuous months next preceding the date of his or her application and has established a domicile in Massachusetts shall be eligible for classification as a Massachusetts student for tuition purposes.

2) Every unemancipated person applying for admission to the University, whose parent has maintained a residence in Massachusetts for a period of not less than one continuous calendar year next preceding the date of application and has established a domicile in Massachusetts, shall be eligible for classification as a Massachusetts student for tuition purposes.

3) Every emancipated person seeking a change in classification who has maintained a residence in Massachusetts for a period of not less than one continuous calendar year next preceding the beginning date of the academic period for which he or she registers and has established a domicile in Massachusetts shall be eligible for such academic period.

4) Every unemancipated person seeking a change in classification, whose parent has maintained a residence in Massachusetts for a period of not less than one continuous calendar year next preceding the beginning date of the academic period for which the person registers and has established a domicile in Massachusetts, shall be eligible for classification as a Massachusetts student for tuition purposes for such academic period.

5) A person having his or her domicile elsewhere than Massachusetts shall not be eligible for classification as a Massachusetts student for tuition purposes except as herein provided.

6) Any person who is registered at the University as a Massachusetts student shall be eligible for continued classification as a Massachusetts student for tuition purposes (until attainment of the degree for which he or she is then enrolled) during continuous attendance at such institution.

7) A member of the armed forces of the United States and his spouse and unemancipated children shall, while he or she is on active duty and stationed in the Commonwealth of Massachusetts, be eligible for classification as Massachusetts students for tuition purposes.

8) A citizen of any other country other than the United States who is in this country on a permanent immigration visa can be classified as a Massachusetts student for tuition purposes if he or she has been domiciled in the state for a period of not less than one calendar year next preceding the beginning date of the academic period for which he or she registered under circumstances indicating his or her intention to reside permanently in Massachusetts.

Change of Classification

Applications for change of classification for tuition purposes are filed with the office of the Dean of Students. Applications for a change to Massachusetts student classification for tuition purposes will not be honored for the then current year if submitted later than the first day of classes.

Penalty for Misrepresentation

Misrepresentation in or omission from any evidence submitted of any fact which if correctly or completely stated would be grounds to deny classification as a Massachusetts student for tuition purposes shall be cause for exclusion or expulsion from or other disciplinary action by the University.

Appeals

Appeal from a determination denying classification as a Massachusetts student shall be initiated by filing a written request with the President of the University or his designee specifying the particular grounds for said request.

NEW ENGLAND REGIONAL STUDENT PROGRAM

Students who meet the eligibility requirements for residents of their state and admission requirements of a University program approved as a regional curriculum will receive preference in admission among out-of-state applicants and will be charged the in-state tuition upon admission. It is assumed that students accepted into a program of study offered under the New England Regional Student Program will remain in the same field of study. If a student transfers into a program which is not included in the regional student program, out-of-state tuition will be applicable as of the date of transfer.

The following is a listing of programs of the University of Lowell which are offered under the New England Regional Student Program.

Lowell Program	**Eligible States***
Environmental Science	Connecticut, Maine, Rhode Island
Health Education	Rhode Island, Vermont
Industrial Technology	Connecticut, Rhode Island
Meteorology	All New England States
Nuclear Engineering	All New England States
Plastics Engineering	All New England States
Radiological Health Physics	All New England States

* Students are advised that the list of approved university programs differs from that which has been approved for state colleges.

FINANCIAL AID

Financial aid consists of scholarships and grants (the awarding of money for which no payment is required), self help in the form of loans (money lent to a student to be paid during a specified period, usually following the termination of University studies), and employment (government or University sponsored work for all or part of an academic year). Awards are made on a yearly basis and are dependent upon the availability of funding from specific sources, proven financial need, and the criteria of specific financial aid sources. *All candidates for financial aid must submit copies of Internal Revenue form 1040 for both their parents and themselves to the financial aid office.*

University Administered Federal Assistance Programs

At the University of Lowell, financial aid is available to students who are citizens of the United States or who have permanent visa status. Aid is granted for the fall and spring semesters, and in some instances, for summer sessions. In order to qualify for financial aid, all incoming and transfer students must file a financial aid form, or if a resident of Massachusetts, a Massachusetts financial aid form. These completed forms must be mailed directly to the College Scholarship Service at the address listed on the front of the financial aid form. The University also requires all candidates for financial assistance to complete a University form and file it with the financial aid office. Copies of these required forms may be secured by writing to the Office of Financial Aid, University of Lowell (South Campus), Lowell, Massachusetts 01854.

Pell Grant

It is the policy of the University of Lowell that all students in need of financial assistance MUST file for the Pell Grant program since the criteria of this program are the basis for determining student needs. All students, except those who have received a baccalaureate degree, are eligible to apply. Applications for these grants may be obtained from high school guidance offices, the office of financial aid, federal post offices, and public libraries. The amount of the grant will be dependent upon funding available and may vary from year to year.

Supplemental Education Opportunity Grant

In conjunction with other forms of financial aid, supplemental grants provide assistance to students of exceptional financial need who would not otherwise be able to consider a college education without attendant indebtedness which would seriously impair future careers.

College Work Study Program

Under the work-study program, a student who meets established financial aid criteria can be assigned part time employment on campus. Students may work 15 hours per week while attending classes full time and may be employed up to 40 hours per week during vacation and summer periods.

Job Locator Program

This program offers part time and summer employment for students with or without financial aid. It is available to provide off-campus jobs. Often students are able to find placement in their field of interest.

National Direct Student Loans

A student may borrow up to $1500.00 per year under this program. Interest, at 5% per year (subject to change), begins 6 months after graduation or withdrawal from the University. The loan is to be repaid within 10 years. To be eligible, students must be American citizens or permanent residents of the United States, must be accepted for admission or already enrolled and in good standing in the University, and have demonstrated financial need. Eligible students should not assume that they will receive a National Direct Student Loan since available funds are inadequate to meet the needs of all qualified applicants. The average National Direct Student Loan is $1,000.00.

Nursing Student Loan Program

The nursing student loan program assists needy students who need financial assistance to pursue a course of study in nursing. The goal is to increase the opportunities for youth seeking careers in nursing by providing long-term, low interest loans. Repayment begins nine months after separation from the University unless military service intervenes, in which case repayment is postponed until nine months after the termination of such service. Simple interest of 6% per year is charged and repayment must be completed within 10 years following graduation or withdrawal from the University. In addition, there are cancellation privileges for nursing graduates who enter into agreement with the Secretary of the Department of Education to practice for at least two years in areas specified by the secretary to be areas of dire need.

Massachusetts Higher Education Student Loan Program

Massachusetts Higher Education Assistance Corporation (MASS-HELP) is a private nonprofit corporation whose purpose is to assist students in financing higher education and vocational training. One type of assistance is called the Higher Education Loan Plan or HELP for short. A HELP loan is a low interest bank loan available to students for educational expenses. The student pays no interest until six or nine months after leaving school, and then has up to 10 years to repay the loan. MASS-HELP guarantees payment of the loan so the banks are willing to lend money to students who have no collateral or established credit standing. An undergraduate student can borrow up to $2500.00 for each school year to a maximum of $12,500 for the undergraduate program. A graduate student can borrow up to $5000.00 for each school year but not more than a total of $25,000.00 for graduate and undergraduate loans combined. A student can only borrow the cost of education minus other sources of financial aid, veteran's and social security benefits, and in certain cases, an amount which a student's family is expected to contribute toward the student's education. The interest rate on a HELP loan, which is 8% (subject to change), is not levied during the student's period of study. Students who desire additional information should contact Massachusetts Higher Education Assistance Corporation, Berkeley Place, 330 Stuart Street, Boston, MA 02116. Telephone (617) 426-9434.

Special Student Loan Programs

Limited loans may be arranged through the office of the dean of students and University Bookstore Associates. Funds for these loans are not derived from state or federal sources.

Dean of Student Loans

Limited, short-term loans are made to cover unexpected personal emergencies. These loans are to be repaid at a time specified by the loan note, which a student must sign at the time an emergency loan is granted.

Bookstore Loans

Students may apply for Bookstore Loans through the University of Lowell Associates, Inc. The maximum amount which can be borrowed by a student over the four-year undergraduate period is $500.00. Repayments made while the student is enrolled in the University are interest free. On those loans which are not repaid until after graduation or withdrawal there is an interest charge at 4% per year beginning three months after termination of enrollment. Repayments become mandatory at the rate of $10.00 per quarter, plus interest, until the loan is repaid. Additional or complete repayment is accepted at any time (Applicants must submit a financial aid form to the College Scholarship Service, Princeton, New Jersey).

SCHOLARSHIPS

Scholarships are provided by the Commonwealth of Massachusetts, the City of Lowell, and the University. Funds for University scholarships are derived from business, industry, and private donations.

Massachusetts Board of Regents of Higher Education

The Board of Regents of Higher Education awards scholarships to qualified residents of Massachusetts on the basis of academic promise and demonstrated financial need. Application for these scholarships must be made on the Massachusetts financial aid form. New applicants should consult their high school guidance counselors for filing deadlines.

Commonwealth of Massachusetts Scholarships

Twenty tuition scholarships are available to residents of the Commonwealth who are enrolled in the freshman class at the University. Awards are made on the basis of combined SAT scores and demonstrated financial need. These scholarships are renewable subject to satisfactory academic standing in the University.

City of Lowell Scholarships

The City of Lowell supports 18 annual scholarships to the University for entering freshmen, 10 of which are reserved for students who have been admitted to the nursing program. These scholarships, for qualified residents only, provide $300.00 during the eight semester undergraduate period. Nursing scholarship recipients who transfer to other majors or who fail to maintain satisfactory academic standing, forfeit their scholarships. Application forms for City of Lowell scholarships may be secured in the guidance office of Lowell High School or the University financial aid office.

University Scholarships and Awards

The University of Lowell has endowed scholarship funds to assist students who satisfy qualification requirements designated by the donors. Upperclassmen are requested to check with their department chairperson for further details.

(Scholarships and Awards Primarily for Underclassmen)

Alumni Association Scholarships:

Scholarships to assist with tuition and/or micellaneous fees and are renewable provided satisfactory academic standing is maintained. Matriculating students are eligible to apply.

American Society for Medical Technology Education and Research Fund:

This scholarship is made available through the Fisher Scientific Company to full time clinical laboratory science students who have completed at least the first semester of their sophomore year and is awarded for completion of both the junior and senior years.

Roland E. Derby Memorial Scholarship:

This scholarship, established in the memory of Roland E. Derby, Sr., provides a $500 scholarship to two sophomore students and is limited to students pursuing degrees in chemistry or chemical engineering. Recipients are selected by the department scholarship committee on the basis of scholastic achievement with due consideration being given to financial need. Scholarships may be renewed for the junior and senior years provided satisfactory academic records are maintained.

Eastman Kodak Undergraduate Scholarship:

This scholarship is granted to University departments from which certain employees of Eastman Kodak have graduated and is awarded in accordance with departmental policies. See your department chairperson.

Genradco Trust Scholarship Fund:

Scholarships are awarded from this scholarship fund to the highest ranking female and male student in each of the three upperclasses, and are restricted to students majoring in industrial technology.

Barnett D. Gordon Award:

The award is made to an incoming freshman who has achieved the highest score in the mathematics examination of the Scholastic Aptitude Test.

Honeywell Fund Scholarship:

A generous gift from Honeywell is to be utilized as follows: 3/4 to be awarded to students solely on the basis of need and 1/4 to be awarded to upperclassmen in the field of electro-optics.

Lowell Sun Charities Scholarship Fund:

This fund, established by the Lowell Sun Charities provides scholarships, renewed annually, for greater Lowell residents. Recipients must demonstrate good moral character as well as high academic standing.

Rosemary Peirent Scholarship Award:

Reserved for an incoming freshman graduating from Tewksbury Memorial High School. Check your school guidance office.

Mark Wagner Memorial Scholarship:

This scholarship is awarded to a student majoring in music. Applicants must be residents of the greater Lowell area for a period of not less than five years, demonstrate financial need, and maintain satisfactory academic standing.

Jacob Ziskind Memorial Fund for Freshmen:

Scholarship funds are restricted to freshmen. Recipients must exhibit good character, scholastic aptitude, initiative, and ability.

(Scholarships and Awards Primarily for Upperclassmen)

AID Awards and Trust Fund:

Awarded to non-traditional minority students in good academic standing, financial need, and either demonstrated leadership ability through community involvement and/or involvement in extra-curricular activity, or have demonstrated very significant academic improvement.

Allied Chemical Corporation Scholarship:

The Allied Chemical Corporation has made available on a one-year basis a scholarship for an upperclassman majoring in plastics.

Michael K. Anderson Memorial:

Established by Irving Anderson in memory of his son Michael, this award is made to a student in the College of Music who is under the age of 25.

Asphalt Paving Scholarship Award Fund:

Awarded to an outstanding senior in Civil Engineering. See department chairperson.

Boston Paper Trade Association Award:

One $300.00 award is available to an upperclassman enrolled in the chemical engineering paper option program. The award is based on character, proven interest in the paper industry, and academic performance.

Custom Materials, Division of 3M Corporation, Scholarship:

Custom Materials of Chelmsford has made available on a one-year basis a scholarship for an upperclassman majoring in plastics technology.

American Hoechst Corporation, Plastics Division, Scholarship:

This company, of Leominster, Massachusetts, makes available two one-year scholarships to deserving students in plastic technology. Recipients must be residents of Massachusetts, with preference given to students living in the Leominster area. Other students may qualify if applicants from Leominster or Massachusetts are ineligible. Qualifications include participation in extra-curricular activities and suitable personality characteristics.

Gehrig Foundation Memorial Scholarships:

Scholarships in the memory of Henry C. Gehrig and his son, Edward, are made available to upperclassmen.

Russell Weeks Hook Scholarships:

Six undergraduate scholarships, two in each of the three upperclasses, are awarded to students majoring in chemistry who can demonstrate financial need. See department chairperson.

Massachusetts Association of Land Surveyors and Civil Engineers:
(MALSCE) Scholarships awarded in memory of Charles Anderson and Llewellyn Schofield. The student must be a civil engineering major, a resident of Massachusetts, and have completed the freshmen year. See chairperson of department.

Mobay Scholarship:

The Mobay Chemical Corporation of Pittsburg sponsors a scholarship on a one-year basis which is awarded to the deserving upperclassman in plastics engineering.

National Association of Plastics Distributors:

$1,000 scholarship awarded to a student majoring in plastics engineering. See department chairperson.

NYPRO (Division of E.I. DuPont de Nemours):

Plastics Engineering. Awarded to a sophomore, renewable for junior and senior years. Preference is given to employees or children of employees or residents of Worcester County area. Must have a CUM of 2.7 or better.

Paper Engineering Scholarship:

Twelve or more scholarships with annual stipends of $500 are available to upperclassmen and selected graduated students who are enrolled in the engineering paper option program. Applicants must have achieved minimum GPA of 2.0. Contributors to this scholarship fund include many nationally known paper companies.

Plastics Engineering:

Each year companies in the plastics industry make funds available for scholarships to students in plastics engineering. Applications may be obtained from the scholarship committee in the plastics engineering department. See department chairperson for details.

Society of Plastics Engineers Scholarships:

Two scholarships are granted annually by the Eastern New England Section of the Society of Plastics Engineers, Inc., to upperclassmen majoring in plastics engineering. One scholarship is awarded by Southeastern New England Section of the Society of Plastics Engineering to an upperclassman majoring in plastics engineering.

Solomont Family Nursing Scholarship Fund:

This fund, established by the Solomont Family provides scholarships to junior and senior nursing majors who show superior promise as professional nurses and who are in need of financial assitance.

Carl Tapper Award:

This award is made to a senior in the College of Music who has established the best record in the two required semesters of apprentice teaching and who shows the most promise for success in a career of music education.

Textile Veterans Association Award:

A medallion and a U.S. Bond are given to an individual who is selected on the basis of scholarship, extracurricular activities, and overall contributions to the University over the four year undergraduate period.

Jacob Ziskind Memorial Scholarship Fund:

This fund established by the Trustees of the Jacob Ziskind Trust for Charitable Purposes, provides scholarships to sophomores, juniors, and seniors who have demonstrated high scholastic accomplishment, exhibit qualities of good character and leadership, and who are in need of financial assistance. Preference is given to those students who have received grants from the Jacob Ziskind Memorial Fund for Freshmen.

Mark Jonathan Elliot Scholarship Award:

The purpose of the award is to encourage recipients to further their education on the graduate level in textile or textile related fields of study.

STUDENT REGULATIONS AND SERVICES

The information provided below covers all matters relating to student life—including student activities and student support services; administration policies governing dormitory residency, automobile registration, identification cards and campus living; regulatory codes of student conduct; and formal processes for investigating student complaints.

RESIDENCE LIFE

The University Residence Life program recognizes that residence hall life can be an important asset to its educational mission and accordingly seeks to provide housing arrangements which not only are compatible with an academic environment but also are positive contributors to the development of personal responsibility, social skills, and student leadership.

Dining halls are located in the Cafeteria Building (south campus), in the Fox Student Union, and Smith Hall (north campus). Resident students are required to subscribe to one of the several food plans of the University. Information concerning available meal plans, dining hall regulations etc. is available through the office of the Dean of Students or residence life.

Residence Halls

The University has six undergraduate student residence halls, which house approximately 1650 students. A brief description of each of these facilities follows:

Bourgeois Hall

Bourgeois Hall is located on Pawtucket Street (North Campus) on the banks of the Merrimack River and can accommodate approximately 330 students (currently all male), chiefly in double rooms. This hall also contains some triple rooms, limited lounge/recreation areas, and laundry facilities. Directly behind the Bourgeois-Leitch dormitory complex is a lighted athletic area with courts for basketball, volleyball, and tennis.

Concordia Hall

Concordia Hall, located on the South Campus overlooking the Merrimack River, is a six story building which houses 186 women. This hall contains lounges, a television room, a recreation area, laundry facilities, a kitchenette, and music practice cubicles with pianos.

Eames Hall

Eames Hall, located at 50 University Avenue (North Campus) adjacent to the Lydon Library, contains laundry and recreation rooms and a television lounge and houses 120 women. The first floor of this building has been extensively renovated to serve the needs of handicapped men and women students.

Fox Hall

Fox Hall, generally referred to as “the towers”, is directly across the street from Leitch and Bourgeois Halls and houses a coeducational population of approximately 500 students on floors 7-18 (single sex by floor) and a student union complex of six floors. Kitchenettes, T.V. lounges, and laundry rooms are located on alternating floors of the residential section. Facilities of the student union section include a fitness center, lounge areas, several meeting and conference rooms, office space for student organizations (including those of the student government, the student year book, and newspaper), and a 700 seat dining hall that services residents of Fox, Leitch and Bourgeois.

Leitch Hall

Leitch Hall is located on Pawtucket Street (North Campus) on the banks of the Merrimack River and can accommodate approximately 330 students (currently all male), chiefly in double rooms. This hall also contains some triple rooms, limited lounge/recreation areas, and laundry facilities. Directly behind the Bourgeois-Leitch hall complex is a lighted athletic area with courts for basketball, volleyball, and tennis.

Smith Hall

Smith Hall, located at 38 University Avenue (North Campus)houses approxiamtely 120 men. A dining hall serving both Smith and Eames is located on the ground level.

General Residence Policy

Rooms in the residence halls are contracted for the full academic year, exclusive of periods when the University is in recess. Students are not permitted to remain in residence halls during periods when the University is not in session. The University is not responsible for providing housing accommodations during vacation periods. Those students who cannot return to their homes during these periods must make their own off-campus housing arrangements. The office of the Dean of Students and residence life maintains a list of off-campus housing.

Residence Costs

The cost for room and board is subject to change yearly. Current prices are available by calling the business office or the office of the Dean of Students and residence life. See Financial Information.

Residence Eligibility

To be eligible for occupancy in the University's undergraduate residence halls, an undergraduate student must have registered at the University as a full-time matriculating student. Full-time registration is defined as an initial semester course load of 12 or more credits or, in the case of EOP students, of 12 or more contact hours. Students matriculating for baccalaureate degrees with less than full time registration, non-matriculating students, graduate students, and continuing education students are eligible for housing only on a space available basis. Individual housing elgibility is not transferable. A student who withdraws from all courses or who withdraws from the University must terminate occupancy of University residence halls.

Residence Assignments

Upperclass students are given the opportunity of signing for the building, room, and roommate(s) of their choice in the spring of each year. Incoming freshmen are assigned housing randomly unless a special request is made to the office of residence life. In that case, every effort is made to honor that request. Changes of room assignment are permitted upon application to the residence staff and with their knowledge and approval.

Housing Priority

Students interested in attending the University of Lowell should note a significant change in the University's housing policy. The mileage restriction in place since 1981 has been lifted and any student living in Massachusetts is now eligible for housing on campus, according to the following policy:

A. Massachusetts residents will be given preference in residence halls.

B. The assignment of space in a residence hall will be given on a first come first served basis.

Rooms will be assigned to these students in the order of the date that their tuition deposit ($100.00 for U.S. citizens and permanent residents, $242.50 for international students) is received by the Business Office.

C. Space in a residence hall is available to out-of-state and international students. However, space is very limited and will also be determined by the date of their tuition deposit.

D. Exceptions to this policy will be made for:

1. Handicapped students;
2. Any exceptional cases to be determined by the Counseling Center and/or the Office of University Life.

This policy might cause hardship for some students. The Office of University Life will, therefore, continue to provide assistance in the area of off-campus accomodations.

Residence hall rooms are furnished with beds, mattresses, desks, desk chairs, and closets. Each student is expected to provide pillow, linen, and blankets. All residents are given a copy of the residence hall rules and regulations with their housing contracts and are subject to these established prohibitions and observances. Any alterations to residence hall rooms must be approved by the director of residence life. Students are encouraged to make their rooms comfortable and liveable but within the guidelines set down in the rules and regulations.

The University does not carry insurance which will compensate students or their families for losses suffered on campus due to such hazard as fire, theft, or water damage. For most families, such insurance is highly desirable, either as an extension of present home insurance or as a special contract.

Residence Hall Staff

Each residence hall is staffed and managed by upperclass or graduate students who have been selected through a very thorough evaluation process. Under the guidance of the resident director, resident advisors lend assistance and support to residents. Resident directors are responsible to the director of residence life, who supervises and coordinates administrative responsibilites which are associated with residence life. Members of the residence life staff may be especially helpful to freshmen who desire information concerning academic and social organizations, cultural and educational activities, and extracurricular activities.

Residence Hall Council

Students are encouraged to become involved in matters affecting their daily lives in the residence halls. Each residence hall elects representatives and officers to serve on a hall council. This body oversees cultural, social, and athletic programs in the building. Each building also chooses its representatives to a campus wide governing body called the Residence Hall Association (RHA). Committees of this organization are concerned with such issues as residential facilities, social functions, athletic programs, and meals. Residents are encouraged to participate in activities which are planned by their hall council and the RHA. During the year councils sponsor such activities as touch football, softball, volleyball, mixers and semi-formals, cook-outs, and roller-skating parties. The RHA organizes trips to Boston and New York at Christmas time.

Residence Hall Contracts

Individual residence halls may develop and adopt rules and regulations of student behavior which are not contrary to established policy of the Board of Trustees. All residents, in any case, are subject to established prohibitions and observances which are specified by official contracts and are further required to comply with University policies concerning billing, health records, automobiles, parking, and food services.

Damage Policy

Residence halls are constructed, equipped, and maintained through funding provided by bonds which have been issued by the University of Lowell Building Authority. Room rents and damage assessments are established to provide a fund which is sufficient to pay building and operating costs. Housing policy requires that a student who has registered for and occupied a room in a residence hall be held financially responsible for rent and for damages both to the occupied room and the common areas. Students are individually responsible for damage to furniture and the quarters which they occupy. In the event of damage to common areas (corridors, lobbies, shower rooms etc.), the cost of repairing such damage will be apportioned among all residents of the concerned residence hall. See Financial Information.

STUDENT ACTIVITIES

At the University of Lowell, the student can find an organization which suits a particular interest whether it be committee organizations, sports, government, religion, the arts, community service, honorary societies, politics, the military, or media. The student government association, residence halls, and student groups sponsor all-campus events throughout the year. The variety of events on campus includes student art shows, concerts, movies, intramural sports, and scholarship awards ceremonies.

Student government associations and interdormitory councils provide unlimited opportunities for participating in student government. Leadership opportunities are provided in residence halls and student organizations. Students also participate in the disciplinary system and on many University committees.

Student Government

The Undergraduate Student Government of the University of Lowell is an elected body whose purpose is to provide a formal means for promoting responsible and effective student affairs; for maintaining academic freedom, academic responsibility, and student rights; and for enhancing educational, social, and cultural opportunities on the University campuses. The Student Government consists of three branches: the Student Senate, the Activities Commission, and the Student Court.

The Student Union

The focal points for student activities are the student union buildings on the north and the south campuses. The Fox Hall Student Union, described previously, contains a student activities area of six floors. The Student Union (south campus) contains a student lounge and recreation area, the south campus student mailroom, offices and meeting rooms for student organizations, the University financial aid office, the University counseling center, and University health services for the south campus.

Athletic Activities

Athletic activities encompass a broad range of options for students to explore and include varsity, intramural, club, and recreational sports.

Athletic Facilities

Costello Gymnasium (north campus), the center for University athletics, houses offices of the director of athletics, coaching staffs, and the department of physical education. The gymnasium, which seats two thousand spectators, includes a collegiate swimming pool, weight-training facilities, areas for gymnastics, wrestling and judo, training rooms, two handball and three squash courts, team dressing rooms, and locker rooms. Adjacent to the gymnasium are athletic fields and four tennis courts. Mahoney Hall (south campus) houses a gymnasium, weight-training facilities, locker rooms and a training room. An athletic field and three tennis courts are located nearby. The office of the coordinator of women's athletics is in Mahoney Hall.

Intercollegiate Memberships

The University of Lowell is a member of the following athletic groups: The National Collegiate Athletic Association (NCAA), Eastern College Athletic Association (ECAA), New England College Athletic Association (NECAA), New England Collegiate Conference (NECC), Collegiate Sports Information Directors of America (COSIDA), and Hockey East.

Varsity Sports

Opportunities to participate in an extensive and varied program of varsity sports are available to men and women students of the University. Approximately twenty-seven activites, covering all seasons of the year, are offered by the University. Intercollegiate teams participate throughout the New England area and the Eastern seaboard. Qualifying teams and/or individuals regularly compete in national tournaments.

Club Activities

The University also offers its students a wide choice of sport activities below the level of varsity completion.

Intramural Activities

The office of the Director of Intramural Activities oversees an extensive and varied intramural program at the University. Four leagues (Fraternity, Sorority, Independent, and Women) compete in such activities as touch football, volleyball, softball, swimming and diving, track and field, basketball, wrestling, turkey trot, hockey, football and softball field days, as well as a wide range of individual activities: handball, squash, chess, badminton, paddleball, bicycle racing, tennis, and cross country. Interested students, faculty, and staff are encouraged to participate in any intramural activity.

Recreation

Students are urged to supplement their intercollegiate, intramural, and required activities with a regular program of recreation. Athletic facilities are available on a recreational basis throughout the year. Equipment needed for most recreational facilities may be obtained from the issue room upon presentation of the student's ID card.

Student Organizations

Honorary and Professional Societies

Alpha Nu Sigma (Nuclear Science and Engineering)
American Chemical Society
American Society for Chemical Engineers
American Society for Civil Engineers
American Society for Mechanical Engineers
American Meteorological Society
American Nuclear Society
Association of the Pulp and Paper Industry
Eta Kappa Nu (Electrical Engineering)
Institute of Electrical and Electronics Engineers
Music Educators National Conference
Pi Lambda (Education)
Pi Mu Epsilon (Mathematics)
Pi Tau Sigma (Mechanical Engineering)
Radiological Health Physics Society
Sigma Theta Tau, Eta Omega Chapter (Nursing)
Sigma Xi
Society for Physics Students
Society for Plastics Engineers
Society for the Advancement of Management
Society for Industrial Technology
Tau Beta Pi (Engineering Honor Society)

Special Interest Organizations and Clubs

A large number of special interest groups and clubs, as well as social fraternities and sororities exist at the University. For a list of such organizations, their statements of purpose, etc., students are directed to the office of the Dean of Students or to the offices of the student government.

ADMINISTRATIVE DISMISSAL, STUDENT REGULATORY POLICIES, AND CODES OF STUDENT CONDUCT

The following pages describe policies concerning administrative dismissal, regulatory policies concerning automobiles, etc., the code of campus behavior (including related disciplinary procedures), and the code of academic behavior (including related procedures for adjudicating charges of academic dishonesty and penalties imposed for academic offenses.)

Administrative Dismissal

A student may be administratively dismissed from the University through cancellation of registration for due cause, through disciplinary procedures for violations of good conduct, or through suspension or expulsion for academic dishonesty. Administrative dismissal also may be invoked when a student fails to comply, after due notice, with an administrative regulation of the University. Official notification of an administrative dismissal is noted on the permanent record card by the symbol "Y", which is entered for each course which has been carried by the dismissed student. Reinstatement of a student who has been administratively dismissed may be made only by application for readmission with the office of admissions and only when the condition which has necessitated administrative dismissal can be ameliorated to the satisfaction of the University officials. Examples of some conditions which may justify administrative dismissal are as follows:

> Forgery or fraudulent use of University records, documents, or forms; unauthorized entry into University records (including computerized records);
>
> Non-payment of tuition, board, room charges, student fees, library fines, overdue University loans, and other official University fiscal obligations;
>
> Failure to comply with a duly authorized administrative order relating to the safety of persons or the protection of University property;
>
> Failure to submit necessary health forms as required by University Health Services; and
>
> Failure to withdraw from the University after certification of a physical health or mental health condition of a hazardous nature.

Regulatory Policies

The following regulations, which require compliance with formal non-academic registration procedures, are concerned with the maintenance of basic standards of good order and conduct on campus and are formulated for the general welfare of students and the University community.

Automobile Regulations

All students owning or driving automobiles are required to register their vehicles with the University at the time of registration, or at the time thereafter when vehicles are first driven to the University, and to place parking stickers on the right side of the rear windows of their automobiles. Students who do not display parking stickers and who park on University property are subject to fines. Student parking is restricted to designated lots. Parking on city streets is permitted only in accordance with posted regulations. Students are not permitted to park in the University driveways or in faculty parking areas.

Identification Cards

Each student of the University is required to possess an official identification card and to present this card when attending University functions or when requested to do so by administrators, faculty, residence hall staff, and campus police. Students are required to surrender their identification cards at the time they withdraw from the University or upon notification of dismissal. Freshmen and transfer students who enter the University at the beginning of the fall semester may secure their identification cards during the period established for freshmen orientation.

Students entering the University at the beginning of the spring semester will be notified concerning the schedule for issuing identification cards. Cards are issued for the duration of stay and are validated each semester at registration. Damaged I.D. cards will be replaced at no charge. A student who has lost his or her card should report this fact to the Dean of Students, Cumnock Hall, North Campus, as soon as possible and should make arrangements at this time for securing a replacement. A fee of $5.00 is charged for issuing a second identification card.

Notification of Changes of Student Status and Address

All changes in student records (including changes of academic programs, course registration, official name, address, and telephone number) *must be made through the office of the registrar*, Southwick Hall, North Campus. Notification given to other offices of the University does not constitute official notification unless also made with the registrar.

International Student Registration

All undergraduate international students must register upon acceptance and yearly in September with the international students office. Students who entered the United States on an F-1 visa will be required to comply with all requirements contained in the I-20 form for their entire stay in the United States. All paperwork (I-20's, I-538's, bank letters, etc.) needed by the international student for travel and finances is processed in the international student office. Sufficent time for preparation must be allowed to process requests for forms and letters. Mandatory insurance for international students is $165.00

University Code of Campus Behavior

The University expects that students will obey University rules and regulations, will not engage in physical or verbal abuse of fellow students or of faculty or staff, and will refrain from misusing equipment, damaging University property, and interfering with the right of administrative offices and staff, faculty members and other students to use University facilities.

The administration and faculty of the University subscribe to the view that students have the right of self-determination over their private lives and public conduct off-campus and accordingly refrain from regulating the extra campus behavior of students. In the case of student misconduct which constitutes a violation of state or federal criminal law, complaint shall be made to the appropriate prosecutor and no administrative punishment will be substituted for appropriate criminal prosecution. The cost to replace or repair University property which has been stolen, damaged, or destroyed will be charged to the offending student(s). Students who violate parking regulations are subject to towing and fines. Continued disregard of parking regulations may subject an offending student to formal disciplinary measures.

The underlying purposes of disciplinary procedures which govern student offenses of a non-academic nature are educational. Such procedures accordingly seek to promote the achievement of self-discipline and self-direction on the part of the student by fostering personal responsibility and accountability. In the administration of these procedures, the University recognizes the legitimate concern of the student body, the faculty, and the administration as committed to a proper balance between protection for the individual and the academic community.

In the imposition of disciplinary penalties, the University makes every effort to avoid dual punishment of an offender for the same wrongful act and therefore refrains from the disciplinary action when sufficent disposition of an offense has been made, or appears likely to be made, by a court of law. Unlawful acts and acts of misconduct which are made off-campus are not the responsibility of the University and are not subject to adjudication by student disciplinary procedures.

The Role of the Associate Vice President for University Life

Except for charges of academic dishonesty, all complaints concerning student misconduct or charges concerning violation of administrative requirements of the University must be forwarded in writing to the Associate Vice President for University Life, who within a reasonable time thereafter, shall provide the student with the name of the complainant, a copy of the charges filed, and a statement of hearing procedures and individual rights of due process. Within five academic days of this notification, the Associate Vice President for University Life shall schedule a personal interview with the student, at which time the student may explain the circumstances of the complaint or charge and/or may affirm or deny the charges or complaint filed, may call witnesses on his or her behalf, and may confront and question those who appear to give testimony within a week of this interview. The Associate Vice President for University Life shall render a decision concerning the complaint or charge filed and shall forward a copy of his decision to the student by registered letter, return receipt requested. In the event that the Associate Vice President has specified a sanction, he shall notify the student of his or her right to appeal the decision to a Board of Appeals and to be represented and/or assisted by a faculty advisor in making such an appeal.

The Associate Vice President for University Life shall have authority to impose a sanction without recourse by the student to subsequent hearings if the student has failed to report for a personal interview as scheduled and has not been excused from reporting for good and sufficient reason. If a student against whom a sanction has been imposed makes no appeal to a Board of Appeals, the punishment determined by the Associate Vice President for University Life shall be implemented within ten days. Pending action on an appeal of sanction imposed by the Associate Vice President for University Life the status of a student shall not be altered and his or her right to be present on campus and to attend classes shall not be suspended unless, in the opinion of the Associate Vice President for University Life and the Vice-President for University Life, failure to implement such sanction may reasonably pose a threat to the safety of persons or the protection of University property.

The Composition and Role of the Board of Appeals

The Board of Appeals shall consist of two faculty members appointed by the Chairperson of the Faculty, two administration members appointed by the Vice-President for Student Affairs, and three student members appointed by a majority vote of the Student Senate. An alternate shall be appointed respectively by the Chairperson of the Faculty, the Vice-President for University Life, and the Student Senate for each regular member designated. Upon written notification to the Board, provided at least two days prior to a scheduled hearing, the student defendant or the Associate Vice President for University Life has the right to remove, without cause, one regular member of the Board and to replace such member with his or her designated alternate. The Board shall elect a person from among its members who shall conduct the hearing and who shall assume responsibility for assuring an accurate record of the hearing.

An official record of the hearing, including a record of testimony, shall be made by a duly appointed stenographer or by tape recorder. The transcript or tape recording shall be for the use of the board only, and upon the conclusion of the hearing it shall be deposited with the Vice-President for University Life, who shall subsequently release this record only at the direction of the President of the University or upon the order of a court of competent jurisdiction. When the student graduates or withdraws from the University, a copy of the official record of the student's hearing may be released to the student when such release has been approved by the President of the University. The original transcript will be kept in the office of the Vice-President for University Life.

The Board of Appeals shall receive a written charge from the Associate Vice President for University Life which provides the name of the accused student and the specific allegation of student misconduct.

A copy of such charge shall be conveyed to the student by the board, together with a notice of time and place of official hearing before the board. The student may be assisted in his or her defense by an advisor of his or her choice, may present evidence, and may call witnesses in his or her defense. Hearings before the Board of Appeals shall be private unless the student has filed a written request for a public hearing with the board at least two days prior to the scheduled hearing date.

Attendance at Hearings of the Board of Appeals

The following individuals shall have the right to be in attendance at a hearing of the Board of Appeals: the Associate Vice President for University Life, the student defendant, the student's advisor, and the legal counsel of the Board of Trustees. Individuals other than those enumerated above who have a direct interest in the proceedings may be permitted to attend hearings at the discretion of the board. The board may revoke such permission at any time during the course of a hearing. A decision to permit an individual's attendance or revoke such permission shall require a 5/7 affirmative vote of the board.

Admissibility of Evidence

Decisions of the Board of Appeals shall be based solely upon the evidence which has been introduced during the official board hearings. Improperly acquired evidence shall not be admitted before the board. In any proceeding, the admissibility of evidence shall be governed by the rules of evidence which are specified by Chapter 300A of the General Laws (State Administrative Procedure Act) concerning adjudication. Information pertaining to the defendant's academic standing or to his or her previous record of offenses shall be introduced in hearing only if the board deems such information to be relevant. Each witness testifying during the hearing shall be called into the hearing room at the time he or she is to testify and shall leave the hearing room immediately after providing testimony. Members of the board, the student defendant, the defendant's advisor, and the Associate Vice President for University Life may question any witness concerning his or her testimony.

Powers of the Board of Appeals

The legal counsel for the Board of Trustees shall be legal advisor to the Board of Appeals. All questions as to the scope of the hearing, legal procedures, legal substance or legal relevancy shall be determined by the board counsel. Following a review of evidence at the conclusion of a hearing, the Board of Appeals by an affirmative vote of 5/7, may affirm, reverse, increase, or decrease a sanction which has been imposed by the Associate Vice President for University Life. Upon conclusion of each hearing, the board shall forward a written statement of its decision, signed by all board members, to the President of the University, the student defendant and the Associate Vice President for University Life. All decisions of the Board of Appeals shall be implemented on the third academic day (including summer session) following the date of the board's notification to the student defendant unless the Associate Vice President for University Life or the student defendant notifies the board in writing of his or her decision to appeal the board's decision to the President of the University.

Appeal to the President of the University

An appeal to the President of the University may be initiated by the Associate Vice President for University Life or by the student defendant and must be made in writing to the Vice-President for University Life within two academic days following notification by the Board of Appeals. The president's review shall be based on the complaint, the decision of the Associate Vice President for University Life, the record of the hearing, and the decision of the Board of Appeals. The decision of the president shall be implemented within ten days following the date of presidential notification to the student defendant unless the student notifies the president in writing of his or her decision to appeal the president's decision to the Student Affairs Committee of the Board of Trustees. In the event that the president alters the decision rendered by the Board of Appeals, he shall provide a written statement of his decision, together with his reasons, to the Board of Appeals.

Appeal to the Board of Trustees

A student defendant has the right to appeal the decision of the President of the University to the student affairs committee of the Board of Trustees.

This appeal must be made in writing to the Vice-President for University Life within two academic days following the date of presidential notification to the student defendant. All decisions of the student affairs committee of the Board of Trustees are final and shall be implemented within ten days.

University Code of Academic Behavior

It is expected that students will conduct their affairs with proper regard for the rights of others and of the University. All members of the University community share a responsibility for maintaining an environment where actions are guided by mutual respect, integrity, and reason.

Terms Used Throughout the Policy:

1. The term "class day" is defined as any day classes and final examinations are scheduled. It also applies to days when University offices are open during the week which immediately precedes the first scheduled day of semester classes. In extraordinary circumstances, the college dean may in his sole discretion authorize extensions of deadlines and may authorize the scheduling of hearings during periods other than the regular academic year.
2. The terms "department chairperson", "college dean", and "college academic standards committee" refer, respectively, to the designated officials and committee of the college in which the concerned course is offered.
3. When a faculty or department committee is responsible for evaluating student work for a course (e.g. Senior Studio Review Committee, Department of Art), the faculty member shall be defined as the department committee chairperson.
4. In the event that all members of the department have served on the department committee which has initiated charges against a student and the membership of such department committee includes the chairperson of the department, the appeal process shall begin with the academic standards committee.

Academic Dishonesty and Prohibited Academic Practice and Behavior

The following is provided for the information of all students and constitutes official notice of prohibited academic practice and behavior including, but not limited to, plagiarism and cheating:

1. Misrepresenting academic work which has been done by another as one's own efforts—whether such misrepresentation has been accomplished with or without the permission of the other individual;
2. Providing or utilizing prohibited assistance (whether in the nature of a person or a resource) in the performance of assignments and examinations;

3. Communicating in any manner with other students during an examination, unauthorized collaboration in the preparation of reports, laboratory reports, or take-home examinations, copying, or giving aid, or otherwise failing to abide by the instructor's specific instructions;
4. Bringing to an examination or using crib sheets, supplementary notes, or comparable aids during an examination session except as specifically permitted by the instructor;
5. Soliciting, obtaining, possessing, or providing to another person an examination or portions of an examination prior to or subsequent to the administration of the examination, without the authorization of the instructor;
6. Substituting for, arranging for substitution by another student, or otherwise representing oneself as another person during an examination session or comparable circumstance;
7. Acquiring from other persons or from commercial organizations, or other sources, or utilizing other unauthorized assistance, and submitting, unattributed, and as one's own work, term papers, research reports, laboratory reports, or comparable documents prepared in whole or in part by others than oneself;
8. The unauthorized or fraudulent acquisition and/or use of another's academic property;
9. Knowingly supplying false information to members of the University faculty or to other officers or employees of the University in pursuit of their official duties, to a conduct committee in the course of a disciplinary proceeding, or knowingly causing false information to be thus supplied;
10. Violation of a published and/or promulgated professional code of ethics to which the student is bound;
11. Unauthorized representation of the University, a University officer, or a University employee;
12. Tampering with or falsifying official records;
13. Direct interference with a faculty member of the University in the performance of his/her official duties;
14. Infringing upon the right of other students to fair and equal access to any University library materials and comparable or related academic resources;
15. Attempting deliberately to prevent other users access to the University of Lowell computer system, depriving them of resources, degrade system performance, or copying or destroying files or programs without consent;
16. Falsification of data collected in the conduct of research or the presentation of falsified data in papers, manuscripts, books or other documents submitted for publication or as course or degree requirements;
17. Direct quotation or word-for-word copying of all or part of the work of another without identification or acknowledgement of the quoted work;
18. An abbreviated restatement of someone else's analysis or conclusion, however skillfully paraphrased, without acknowledgement that another person's text has been the basis for the recapitulation;

19. Presenting, as one's own, the ideas, work product or words of another person or persons for academic evaluation without proper acknowledgement.

The statements set forth above do not constitute an exhaustive listing of prohibited practice. Accordingly, there may be other instances of academic dishonesty which may occur. Their identification will require the prudent judgment of appropriately involved faculty. The above statements of practice apply to all University of Lowell students regardless of the academic unit with which they are affiliated or within which they are enrolled.

Obligations of Faculty Members to Students

Faculty members shall take all reasonable steps to prevent cheating by students in their courses. Although each student is responsible for complying with the above notice of prohibited practice and behavior, faculty members are responsible for publishing their special requirements for completing assignments and taking examinations. Such requirements must be explicitly made through examination and assignment directions.

Preservation of the integrity of the academic process is an exercise of professional judgment and is both a faculty right and a faculty duty. The rendering of a professional judgment when charging or adjudicating an academic offense must be honest and fair and must ensure due process, including notification to the student of the particulars of a charge of academic dishonesty and the penalties which will be imposed or recommended.

In assessing penalties for academic dishonesty or prohibited academic practice and behavior, faculty members and designated authorities of the appeal process should consider the nature of the offense, the question of premeditation, and any previous record of dishonesty or violation of prohibited practice and behavior. Neither the student nor the University can be served when the punishment is not proportionate to the offense.

Process of Notification and Adjudication

Depending upon the circumstances of time and place when academic dishonesty has been detected and the severity of penalty which the faculty member wishes to impose, notice to the student concerning alleged dishonesty and/or violation of prohibited academic practice and behavior may be provided through either a formal or informal procedure. *Should the faculty member fail to notify the student of a charge of academic dishonesty and/or prohibited academic practice and behavior through either an informal oral notification of charges, or formal written notification of charges, no penalty may be imposed.*

1. Informal Procedure

   The informal notification procedure may be used only in the following instances: 1) in cases of observed cheating or observed violation of testing or classroom assignment requirements; 2) in cases of reported cheating or violation of classroom testing or assignments, detected plagiarism, or other cases occurring prior to the final examination in which the commission and detection of academic dishonesty are not coincident; and 3) in cases for which the recommended penalty, per se, is less than course failure.

   The informal notification procedure may NOT be used for offenses which are detected during or after the administration of the final course examinations or (in the event that no final examination is administered) after the last class of a semester and may not be used if the faculty member wishes to impose penalties which range from course failure to academic suspension or expulsion from the University.

In cases of observed cheating, the informal procedure includes oral notification of the student prior to the end of the examination or class period and appropriate written comment on the student paper which shall include a statement of the penalty to be imposed. In those cases wherein the commission and detection of academic dishonesty are not coincident, the faculty member shall provide notification by making an appropriate written comment on the paper or assignment which shall include a statement of the penalty to be imposed.

Within three class days of notification, the student may request a meeting to discuss the charge and the penalty specified, and the faculty member shall schedule such meeting. The purpose of the informal meeting is to clarify possible misunderstandings between the student and the faculty member, to discuss the impact of the proposed penalty upon the student's final grade, and to pursue any question relative to the charges and penalties. At this meeting, or within three class days of this meeting, the student shall advise the faculty member if he or she accepts the charge and penalty imposed or alternatively the student may initiate a formal appeal with the department chairperson. If the student does not initiate a formal appeal, the charge may not be challenged and the penalty may not be appealed. In the event that a formal charge of academic dishonesty is initiated by a department chairperson, the chairperson shall be replaced in all stages of the appeals procedure by a senior faculty member of the department in which the violation is alleged to have occurred.

2. Formal Procedure

The formal procedure for notification and adjudication shall be used in the following instances: 1) in cases of observed cheating or violation of testing procedures during the final examination; 2) in cases of cheating or plagiarism which are detected after the final examination or after the last class of the semester; and 3) in cases for which the recommended penalty ranges from course failure to academic suspension or expulsion.

In each of the above cases, the faculty member shall provide the student with formal written charges of alleged dishonesty or violation of prohibited academic practice or behavior. During periods when classes are in session, such charges either shall be given to the student in person or shall be sent to the student's campus mail box. During periods when classes are not in session, such charges shall be sent to the student by certified mail (return receipt requested) at his or her official home address of record as filed with the University. Notification, as above, shall be given to the student or mailed within three class days of the time when the faculty member became aware of the alleged student offense or by the last day for filing semester grades with the office of the registrar, whichever is earlier. A copy of written charges shall be forwarded to the department chairperson, the chairperson of the college academic standards committee, and the college dean.

A formal adjudication of a charge of academic dishonesty also may be initiated by the student pursuant to written appeal from the informal procedures. In such case, the faculty member shall provide a formal written statement of charges to the student, the department chairperson, the chairperson of the college academic standards committee, and the college dean within two class days of the student's notification of intent to appeal.

Department Chairperson Hearing

Within seven class days of receipt of a formal notification of academic dishonesty, the department chairperson shall hold a meeting with the faculty member and the student to discuss the charges and recommended penalty. Within three class days the department chairperson shall notify the parties of his or her judgment by certified mail, or by hand delivery. If there is no further appeal, the chairperson's decision shall be final.

College Academic Standards Committee Hearing

Either the student or the faculty member may appeal the chairperson's decision to the college academic standards committee. This appeal must be made within three class days of the notification of the chairperson's decision by certified mail or by hand delivery. The college academic standards committee shall meet with the department chairperson, the faculty member, the student and any witnesses to the alleged offense within seven class days of receipt of the requested appeal.

Hearing Procedures

a. No member of the committee shall have any prior involvement in the alleged offense. Removal of any member of the committee shall be at the discretion of the committee chairperson.

b. The hearing shall be open except at the request of the accused student or the complainant. The committee chairperson may in his discretion close the hearing in order to protect complainant witnesses or other parties.

c. An accurate, but not necessarily verbatim, record of the proceedings will be kept by a person (the recorder) assigned by the committee; that record will be maintained in secure fashion by the committee.

d. Responsibility for recognizing and calling persons to speak lies with the chairperson.

e. Persons disruptive to any stage of the hearing may be evicted at the reasonable discretion of the chairperson.

f. The department chairperson shall first present the results of the investigation and/or the charges against the student.

g. The department chairperson and/or the complainant witness may present oral testimony and/or written statements from any person including the suspected student.

h. The student may then present written documentation or oral testimony from the student him/herself and/or other witnesses.

i. At any time during the proceedings, members of the committee may question witnesses or parties of the proceeding; witness or parties may ask questions at the discretion of the chair. Legal counsel and/or advisors may not speak at the hearing.

j. After the presentation of all the evidence to the committee, each party may present arguments to the committee on the applicability of this policy or the interpretation of any sections herein.

k. During the hearing the committee may consider any relevant information, shall not be bound by the strict rules of legal evidence, and may take into account any information which is of value in determining the issues involved. Efforts will be made to obtain the most reliable information available.

l. After the parties present their respective information, the committee shall go into closed session to determine whether the student has committed the alleged violation(s) and, if so, the sanction(s) to be imposed. A member should vote against the accused student only if convinced by a clear preponderance of the information presented that the accused student has committed the act(s) as charged. A majority vote of committee members present and voting shall prevail.

m. After making its decision, the committee shall inform the student in writing by certified mail, return receipt requested, within three class days of the disposition of the case. Any disciplinary sanction(s) imposed by the committee shall be operative immediately unless appealed.

n. The student or the faculty member has a right to appeal to the college dean within three days of notification of the committee's decision. The appeal shall be in writing to the college dean and either hand delivered or by certified mail, return receipt requested.

o. The notice to the student of the finding of the committee shall include:

1. The facts found to be true.
2. The section of this policy found to have been violated.
3. The disciplinary sanction imposed or other sanction to be taken.
4. Right of appeal and procedure set forth in (n.) above.

College Dean Hearing

The college dean shall meet with the chairperson of the college academic standards committee, the department chairperson, the faculty member, and the student within seven class days of the requested appeal. The college dean shall make his decision based on the documents submitted to the college academic standards committee, the record of the committee hearing and statements or responses to questions by the chairperson of the college academic standards committee, the department chairperson, the faculty member and the student. Within three class days, the college dean shall notify the concerned parties of his or her decision by registered mail, return receipt requested. The decision of the college dean shall be final and hence may not be appealed.

Right of Student to Counsel at Hearings

A student who has been formally charged with an academic dishonesty offense may request representation from the office of the dean of students, the counselling staff, or the full-time faculty to provide aid and assistance at any stage of formal hearings. Such counsel shall be provided with copies of documents which have been forwarded to hearing authorities and he or she shall be present for all formal hearings. Legal counsel may be present for either the student or the University but may not participate in hearing deliberations.

Special Provisions

While an appeal process concerning an academic offense remains unresolved, the charge shall not prejudice the right of a student who has not otherwise been suspended for unsatisfactory academic performance or student misconduct from continuing his or her course of study at the University.

The timetables which have been specified above for the conduct of appeal processes have been developed to insure the speedy resolution of both the charges and the student's University status. In the event that resolution of a charge of academic dishonesty cannot be made prior to the beginning of next semester and a charge of academic dishonesty is subsequently sustained and the penalty imposed either requires or results in academic suspension or expulsion, the student shall be dropped from the University immediately and may not be permitted to complete courses for which he or she may have been registered. Under these circumstances, the student shall be reimbursed on a pro-rated basis for course tuitions and dormitory and meals fees if housed in a dormitory. If a student is dropped from the University during the same semester as the offense occurs, no reimbursement is required.

A party to an appeal hearing who is unable to attend his or her hearing as scheduled must notify the appeal authority as soon as possible, preferably one day in advance. The hearing may be postponed/rescheduled for good and sufficient reason acceptable to the appeal authority.

If, without prior approved notice, the appealing party has failed to appear as scheduled for an appeal hearing, an appeal authority at any level may resolve a charge of academic dishonesty and/or may impose a final penalty; provided however, that a penalty of academic suspension or expulsion from the University shall require the concurrence of the college dean.

A party of an appeal hearing who was unable to provide prior notice of his or her inability to attend an appeal hearing as scheduled may submit an academic petition to the college dean requesting a rehearing before the appropriate authority. The college dean may grant a hearing for reasons of serious illness, accident, critical personal or family emergency, or other such acceptable reasons, and his or her decision concerning a rehearing shall be final.

Penalties for Academic Dishonesty or Prohibited Academic Practice and Behavior

Except as noted below, penalties for academic dishonesty or prohibited academic practice and behavior which are adjudicated through the informal procedure are limited to the administration of an alternative assignment or substitute examination which shall be at the sole discretion of the faculty member, failure of an examination or assignment and denial by the faculty member of permission for the student to withdraw from the course before the 40th class day.

Penalties for academic dishonesty or prohibited academic practice and behavior which are adjudicated through the formal procedure (including cases appealed by the student from an informal adjudication) may range from the administration of an alternate assignment or substitute examination at the sole discretion of the faculty member, failure of an examination or assignment (and the consequent lowering of final course grade) through course failure (including denial of permission to withdraw from the course in question before the 40th class day) to academic suspension or expulsion. The penalty of academic suspension, which may be imposed for a semester or academic year, and the penalty of dismissal from the University (expulsion), which shall be permanent, may be imposed only by the college dean. In the event the dean of the college in which an academic offense has taken place shall approve or impose either a penalty of academic suspension or dismissal (expulsion) from the University upon a student who is matriculating for a degree in a college other that that in which the academic offense has taken place, the imposition of such suspension or dismissal shall require the concurrence of the dean of the college in which the student is matriculating. If the deans do not concur, they shall arrive at a mutually agreeable penalty and such decision shall be final.

The semester grade filed by a faculty member for a student who is the subject of an unresolved or pending allegation of academic dishonesty shall be an "Incomplete," with an end of course letter grade which shall be assigned in the event that the student makes no appeal or the charge is sustained through appeal and the penalty is reaffirmed. If the determination of penalty which is made at the last step of the appeal process, as invoked, is different from that which was initially made, the faculty member shall file a correction of the final grade which is in compliance with the final determination.

Special Procedures for Penalties Relating to Legal Professional Licensure and/or Certification

The implication of academic dishonesty or violation of prohibited academic practice and behavior for ethical standards which are specified by law for professional licensure and/or certification are questions which properly reside with professional review bodies. Hence, a decision concerning student continuance or discontinuance in a professional program which requires legal licensure or certification shall not be made by an individual faculty member or by designated authorities of the appeal process defined above.

Following the imposition of a penalty for academic dishonesty by a faculty member or by designated authorities of the appeal process defined above, the status of a student who is enrolled in a professional program which requires licensure or certification may be reviewed by an established professional review body by request of either the student or the University. If, in the opinion of the professional review body, the nature of the academic violation warrants discontinuance of the student's enrollment in the professionl program, it shall so notify the student and the University; the student shall either withdraw or shall be dropped from the professional program. The decision of a professional review body is final and may not be appealed to the college dean.

PROCEDURES FOR ADJUDICATING STUDENT COMPLAINTS

The procedures described below provide students with formal avenues of complaint concerning alleged faculty violation of academic policies and arbitrary disregard of published syllabusses or course requirements, classroom problems arising from faculty and/or student actions which are a source of legitimate concern, and alleged cases of faculty discrimination or faculty and/or student harassment.

Complaints Arising from Grades and Grading Policy of the Faculty Member

Faculty are expected, as a matter of right and professional standards, to recompute any grade in which a computational error is alleged or suspected, provided that the student challenges the grade before the deadline established by the calendar for filing final course grades and grade changes. *However, no challenge or appeal shall be allowed in the matter of grades and grading policies except when a faculty member is alleged to have violated University, college, or department academic regulations and policies, or the faculty member's own grading policy,* the latter to be determined from the published course requirements for the course or section in question. Appeals of grades or grading policies arising from alleged violations of established or published policies will follow procedures cited below under the heading "Complaints Concerning Classroom Matters".

The terms "grade" and "grading policy" refer 1) to all grades awarded, 2) to the computation of grades for examinations (including final examinations), tests, quizzes, papers, essays, laboratory reports, practicum experiences, and any other kind of academic activity for which a grade of any kind is awarded, and 3) the final course grade which is submitted to the office of the registrar.

Complaints Concerning Classroom Matters Exclusive of Grades and Grading Policy

Students confronting classroom problems which are a source of legitimate concern are entitled to have their complaints heard and resolved according to the procedures specified below.

Classroom problems may include, but are not limited to, the following examples.

1) faculty failure to observe University policy and/or regulations, such as violating the regulation against scheduling examinations during the last week of the semester,
2) changing class schedules without the permission of the department chairperson and the college dean, rescheduling of final examinations (including setting a due date for take-home examinations) to a time and place other than that established by the office of the registrar,
3) terminating semester classes prior to the date specified by the University calendar,
4) failing to fulfill instructional obligations (such as unjustified cancellation of classes, frequent absenteeism, and lateness),
5) failing to provide and distribute a written statement of course requirements which is mandated for all instructors,
6) failing to adhere to the written statement of course requirements, and
7) failing to post office hours or to maintain such hours.

Students normally should seek to resolve problems by discussion with the faculty member. If this is not feasible (e.g., for reasons of intimidation or threat) or if, after discussion, the matter cannot be resolved, the student shall inform the faculty member in writing that he or she will initiate a formal complaint. This complaint shall be in writing and shall be addressed jointly to the chairperson of the department and the dean of the college in which the alleged problem and/or violation occured. After discussing the problem with the student and the faculty member, the chairperson and the dean will make a determination. Should the subject of a formal complaint be a department chairperson, the review and determination will be made by the dean and the chairperson of another department. Copies of the complaint, together with the written decision of the chairperson and the dean, shall be sent to the student, the faculty member, the vice president for academic affairs, and (in cases involving faculty/librarian unit members) to the president of the MSP.

Formal complaints about classroom problems shall be initiated before the last day of the semester examinations in the semester during which the violation is alleged to have occured. The determination of the chairperson and the dean shall be made within ten working days following receipt of the student complaint and, if unchallenged by the MSP, shall be final.

Discrimination and/or Harrassment

Any student who believes that he or she has been discriminated against on the basis of sex, race, color, national origin, creed, religion, age, handicap, or veteran's status or that the University in any of its aspects is operating in a manner which adversely affects female, minority or handicapped students or veterans should contact the Affirmative Action Officer/Coordinator for Title IX and Handicapped Affairs immediately. Alleged discrimination or harassment which does not come under the purview of the affirmative action office should be pursued in accordance with the procedures outlined above for the resolution of classroom problems.

STUDENT SERVICES

Student services include a number of offices with primary concern for student support, as well as services and programs which are conducted by the faculty and administrative staff for the enrichment and well-being of student constituencies and for the protection of individual rights.

Library Services

The University of Lowell Libraries provide professional reference services to the students, staff, faculty, and alumni of the Univeristy in the following areas: bibliographic instruction, interlibrary loan, computerized literature searches, manual literature searches, and specialized classes in search techniques. In addition, specialized services in government documents are provided by the reference department. All cataloging of new material is accomplished using the bibliographic database and terminals of the national network, OCLC. With the purchase of the ALIS II computer system in 1979, the library has proceeded to build one of the more advanced public on-line catalogs in the nation.

The media services unit of the University Libraries operates facilities in both library buildings and provides services for media presentation, media production, and music listening. Media production (encompassing audio, video, and slide production) and media presentation (providing the use of screening facilities and the loan of film and video equipment) are academic support units. The music listening room supports academic programs but is also available for recreational listening.

Library Regulations

New students should have their pictures taken for an identification card at the beginning of the academic year. This photo-identification card must be presented whenever a student wishes to take materials from a library and, upon request, for admission to either of the two libraries. The identification card is valid until graduation, termination of enrollment or revocation, and is not transferable. The owner of the identification card is responsible for all material charged to his or her card up to the time that library authorities have been informed that the card has been lost or stolen.

Students are not permitted to bring food or beverages into library areas and are prohibited from socializing, conversing, or generally engaging in inappropriate activities in a library setting. A student's library privileges, including the right to study in library areas, may be revoked when library rules concerning conduct have been violated.

Circulation and Fine Policy

The fine for regularly circulating books at the University of Lowell is .10 cents a day, with a maximum limit of a $10.00 fine on each book. Students who lose books must pay their current replacement costs plus $3.00 per lost book for processing. The fine for overdue reserve books is $1.00 a day.

Books will not be renewed if they are not returned to the library for recharging and are never renewed by phone.

Borrowing Privileges per Patron Category:

	Charge Limit (Books)	Charge Length (Days)	Renewals	Renewal Length (Days)
1. Alumni	10	14	2	7
2. Eve. Graduate	10	14	2	7
3. Eve. Undergraduate	10	14	2	7
4. Day Undergraduate	15	14	2	7
5. Day Graduate	25	14	2	7
6. Grad. Assistants	30	30	2	30

The library will put a hold on diplomas and/or transcripts of a student who has an outstanding debt for fines or loss of books. In exceptionally serious cases, the library reserves the right to institute formal disciplinary proceedings which carry penalties up to and including dismissal from the University.

The library will suspend borrowing privledges for patrons who owe $1.00 or more in fines, or who exceed the specified charge limit.

All patrons must register with the library each semester. Information concerning the University library system and interlibrary loan services is available at the reference desk.

University Bookstore

The University Bookstore is operated by the University of Lowell Associates, Inc. The north campus bookstore is located in the basement of Falmouth Hall. The bookstore for the south campus is located in the basement of Coburn Hall. Books, materials and supplies for courses taught on north campus are sold through the north campus store, while south campus courses are serviced by the south campus store.

Special Academic Services

The office of Special Academic Services (SAS), which is dedicated to the retention of non-traditional students, provides special programs in skills development and supportive services for matriculating students and administers two related programs of assistance. The Alternatives for Individual Development program (AID) provides on-going counseling, tutoring, and limited financial aid; sponsors cultural enrichment activities; and offers classes in reading and writing techniques. Individuals qualifying for this program who are newly admitted to the University also are given the opportunity to participate in a precollege refresher program which is offered during the summer. The Educational Opportunities Program (EOP), described elsewhere in this publication under the heading "Admission Policies," serves qualifying individuals from disadvantaged environments.

The student learning center provides courses in skills development and tutorial assistance for EOP and AID students and other University students who qualify for such services. The following courses are offered: Foundations of English, Foundations of English as a Second Language, Foundations of Reading, and Foundations of Mathematics. In addition, the center offers skills-development workshops and tutorial assistance in varied subject areas.

Campus Security

The campus security force is responsible for the security of University property, students, and employees and for parking control. Guards are assigned to parking control duties during the day and patrol of reisdence hall areas at night. Student ID cards or other means of identification must be shown upon request to any properly identified member of the security force. The policies of the campus security force are governed by applicable federal, state, and local laws and by regulations of the Board of Trustees. In addition, members of the campus security force are guided by a code of ethics adopted by the International Association of College and University Security Directors.

Student Advising and Counseling

Student problems of a non-medical, non-academic, or non-psychological nature should be directed to the office of the Dean of Students. Academic problems should be referred to faculty advisors. The University recognizes that collegiate work is often done under conditions of stress, and faculty members are available for student conferences should a student so request.

Special counseling and academic advising are provided as follows:

Academic Advising: Faculty Advisors, Department Offices
Career Counselling: Counseling Staff, Student Union, South
Foreign & Minority Student Advising: Mrs. Gladys Coughlin, Office of the Dean of Students, Cumnock Hall
Personal Counseling: Counseling Staff, Student Union, South
Pre-Medical and Pre-Dental Advising: Dr. David Eberiel, Department of Biological Sciences, Olsen Hall
Veteran's Affairs: Veterans Office, Pasteur Hall
Pre-Law Advising: Prof. Leonard Andrusaitis, Mathematics Department, Olsen Hall

Counseling and Career Development Center

The Counseling and Career Development Center, which is located on the third floor of the south campus Student Union Building, provides services to all students in the areas of personal adjustment and development, career development, educational planning and mental health. All services are free of charge. Individual and group counseling are offered for personal difficulties and interpersonal problems which interfere with academic and personal growth. Support groups for older students returning to school, and workshops to develop better communication skills and appropriate assertive skills are conducted regularly.

In the area of academic support, the center offers workshops for the development of better study skills and for managing test-taking and performance anxiety. Students may call on center personnel to help resolve problems with members of the faculty or of the University administration.

Specialized career development services are provided both through individual counseling and workshops. These are designed to assist students in choosing a major field of study and in making career development decisions consistent with their skills, interests and values. Where requested, programs are conducted in conjunction with academic departments and student organizations. A career development resource library is open on a walk-in basis during normal office hours. Counselors are available to assist students in using these resources.

The Counseling and Career Development Center is open from 9:00 to 5:00 each day, and at other times by arrangement. Students are encouraged to drop by any time or to call for an appointment on Extension 2390.

Disabled and Handicapped Students

The University is becoming increasingly more accessible to academically qualified students who are physically disabled. Although some architectural barriers still remain, disabled persons can traverse the campus with a minimum of difficulty. University Libraries, the Student Unions, Eames Hall, and more recently constructed classroom buildings are accessible to students in wheel chairs. Early registration, preferential scheduling, housing assistance, a reader's directory for the blind, alternative testing procedures (e.g., verbal rather than written examinations for the blind or manually impaired), and speical parking arrangements are some of the special services available to disabled students. Since admission to the University is based entirely on the academic qualifications of the applicant, admission procedures remain the same for all applicants, regardless of disability. For further information, contact the Dean of Student's office, Cumnock Hall (North Campus).

Equal Opportunity and Title IX

Federal and state laws require that no student be discriminated against or harassed on the basis of age, national origin, race, religion, sex or handicapped, marital, or veteran's status. The Affirmative Action office, which has the overall responsibility for the implementation of Equal Opportunity/Affirmative Action, is located on the second floor of Dugan Hall (south campus). This office deals not only with discrimination and harassment complaints but also with the monitoring of actual practice and written policies and procedures, e.g., student activities, course offerings, teacher and student attitudes. Any student who believes that he or she has been discriminated against or harassed or who believes that the University in any of its aspects is operating in a manner which adversely affects female, handicapped, minority students, or veterans should contact the Affirmative Action office immediately.

Health Services

The University maintains a student health service office on the north campus at 30 Standish Street, which is open from 8:00 a.m. to 4:30 p.m., Monday through Friday. This office is staffed by a nurse practitioner and registered nurses as well as by part-time physicians and a part-time nurse practitioner.

Services include acute and routine medical care, gynecological care, allergy injections, specialty referral, hypertension screening, tuberculosis testing and health education. A first aid station for the treatment of minor injuries is also open 8:00 a.m. to 11:30 a.m., Monday through Friday in the south campus student union. In case of an emergency when the health service is closed, medical care is available on a 24 hour basis at the three local hospitals. Students requiring assistance from security are instructed to call 2666.
The University Health Service and the University are not responsible for students who become ill while on campus or who are injured while participating in class activities, university sports, or extra-curricular activities.

Student accident insurance coverage for the academic year is obligatory and is included in the Student Activities Fee. Medical and surgical insurance is available at a nominal fee at the time of registration in September. This additional coverage is required for international students and is optional for non-international students. Insurance claim forms may be obtained at both campus health offices and it is the responsibility of the student to complete these forms as soon as possible after an illness or accident. Failure to comply within the compulsory reporting period may result in the forfeiting of insurance claims. Hospitalization and medical treatment are obtained for a minor student only upon permission of the student's parents or guardians and at their expense.

Emancipated students must assume responsibility for necessary hospitalization and medical treatment.

Any student, faculty member, or employee incurring an injury at the University is advised to report to the Health Service for treatment. If the injury is sufficiently serious to warrant further medical attention, the nurse on duty shall make an appointment with a physician of the patient's choice. It should be understood, however, that if it is necessary for the injured to be treated by a physician, the injured person, if not an employee of the Commonwealth, must assume the responsibility for payment of the physician's fee.

Mail Boxes and Postal Services

Student mailrooms are operated by the University of Lowell Associates, Inc., for the convenience of students. On the north campus, the mailroom is located in the basement of Pasteur Hall. The south campus mailroom is located on the 2nd floor of the Student Union building. Each student is assigned a mailbox during registration. Since incoming mail, administration notices, and faculty communications are placed in student mailboxes daily, *students are expected to check their mailboxes daily.* Mailroom facilities are made available to clubs and organizations for the purpose of distributing notices and advertisements, providing that such distribution is made by club personnel rather than by mailroom employees. Mailroom hours on both campuses are from 8:30 a.m. to 12:00 noon and from 1:00 p.m. to 4:30 p.m. The mailroom will not receive items for distribution after 4:00 p.m.

Placement Services

University placement services include dissemination of vocational information and career interviewing services. The office, located in Southwick Hall, north campus, advises students on employment opportunities and arranges for employers, representatives from business, industry, government, hospitals, schools, and other areas to visit the campus during the year to interview prospective graduates. A basic resource library in the office provides occupational information, industrial literature, graduate school information, and self-help career aids. The credentialing service provided by the office affords a place for each student to establish and maintain an up-to-date file of personal records, a developmental resume, letters of recommendation, and other supportive documentation. Copies of student credentials are sent to prospective employers upon their request or at the request of the student.

Activities conducted by the University placement services include the following: letter writing clinic, resume writing clinic, salary negotiations, travel-business etiquette success seminar, full and part time job placement, graduate placement, company and agency personnel planning, business agency tours, and guest speaking services.

The placement office also provides information concerning teacher certification requirements for students who plan to teach in the public schools. However, students enrolled in an approved program of teacher education should inquire at the office of the dean, College of Education, concerning certification procedures.

General Policies Concerning Placement Credentials

1. Upon registering with the placement office, each senior receives appropriate forms which he or she must complete for his or her placement file and supplies the placement office with the names of three faculty members who have agreed to write letters of recommendation for forwarding to prospective employers or to graduate schools. Recommendation forms are sent directly to specified faculty members. For each recommendation desired, the registrant must complete a form which indicates the purpose of the requested recommendation (i.e., graduate study or job placement) and specifies the subject area of graduate study or the nature of the employment sought. In order to assist faculty members in focusing their letters of recommendation, this form will be sent to designated members of the faculty at the time when recommendation forms are forwarded from the placement office.
2. The placement office will not honor requests of registrants to reveal the contents of confidential letters of recommendation or evaluation reports which are on file and for which the student has waived his or her right to inspect. Registrants may request faculty members to make known their recommendations and evaluations prior to submission to the placement office. Since a faculty member is free to refuse such a request for disclosure as a condition for writing a letter of recommendation, the registrant should decide if he or she will require disclosure prior to asking a faculty member for a letter of recommendation. Students should report to the placement office only the names of faculty members who have their confidence and who have agreed to any disclosure which they may require. In the event that a registrant wishes to have a recommendation or evaluation removed from his or her placement file, the registrant should notify the placement secretary in writing. A recommendation or evaluation which has been removed from an individual's file upon his or her written request will be returned directly to the author or will be destroyed in the event that the author is no longer an employee of the University.
3. Placement papers will be sent only to bona fide employers at their professional or business addresses or to recognized admission officers of colleges and universities.
4. Any attempt by a registrant to gain access to his or her confidential placement papers through fraudulent means will result in automatic cancellation of placement privileges. In the event of such cancellation, all confidential letters will be returned to the authors (or will be destroyed) and non-confidential materials will be returned to the registrant.
5. Until such time as a registrant revokes his or her authorization in writing, an individual's signature on documents filed with the placement office shall be considered as written authorization to forward all documents which comprise his or her complete placement file to any bona fide employer or recognized admission officer.

RIGHT OF ACCESS TO STUDENT RECORDS

The Family Rights and Privacy Act of 1974 grants to any student currently in attendance, or to a former student, the right of access to inspect or review his or her educational files, records, or data. Students who wish to inspect their records must file a "Right of Access" form with the office or department in which the desired record is kept. Right of access forms are available in the office of the Dean of Students. Within ten days of receipt of the right of access form, the office or department will notify the student as to the date, time, and location when the desired record will be available for inspection.

The University maintains the following general records on students:

Admission File:	Admissions Office, Dugan Hall, South Campus
Permanent Academic Records:	Registrar's Office, Southwick Hall, North Campus
Financial Aid Records:	Financial Aid Office, Student Union Building, South Campus
Health Records:	Health Services Building, North Campus
Temporary Academic Records:	College Dean, Department Chairperson or Faculty Advisor
Account and Payment Records:	Business Office, Dugan Hall, South Campus

The file of each student must contain a record of all non-University affiliated individuals or organizations requesting access to it, plus statements which specify the legitimate educational purposes for which access was requested. The record of access may be released only to University personnel or to state or federal officials as a means of auditing the reporting of access to student records.

Information or records concerning individual students may not be released to any individual or agency without written permission of the student. Any request for such information received without such written notice will not be honored and will be returned with a request for a written release by the student.

Educational records may be released without permission to the following individuals or agencies under the following specific conditions:

1. Personnel of the University, i.e., faculty, administrators, or staff for legitimate educational purposes only;
2. Officials of other institutions in which the student is enrolled, provided that the student is notified of the release;
3. Federal or state officials in connection with the audit and evaluation of programs funded by the federal or state governments or in connection with the enforcement of legal requirements which relate to such programs or in connection with the student's application for or receipt of financial aid;
4. State and local officials pursuant to any state statute adopted prior to November 19, 1974;
5. Organizations conducting studies for the purpose of developing predictive tests, administering student aid programs, and improving instruction;
6. Accrediting organizations in order to carry out their accrediting functions;
7. Parents who claim the student as a dependant on their IRS statement; and
8. When necessary in an emergency, to protect the health, safety or welfare of the student or others, to persons who are in a position to deal with the emergency.

The following data is considered informational in nature and may be released, without permission of the student, at the discretion of the University: name, address, telephone listing, date and place of birth, participation in officially recognized activities and sports, height and weight of athletic team members, dates of attendance, degrees and awards received, and most recent previous educational institution attended. Any student who believes that his or her records are inaccurate or misleading may request a hearing with the Dean of Students to discuss the contents of such records. Additional information on procedures or policies relating to University compliance with the Family Rights and Privacy Act can be obtained from the office of the Dean of Students.

UNIVERSITY ACADEMIC POLICIES

Each University student is subject to two sets of academic regulations—those of the University as a whole, which are cited below, and the academic rules of the college and program in which he or she is enrolled. The academic rules of colleges and programs are listed in chapters devoted to college programs.

In registering for courses, each student assumes full responsibility for knowledge of and compliance with the definitions, regulations, and procedures for the University, as set forth in this publication. Moreover, in accepting admission to the University, each student assumes responsibility for knowledge of and compliance with the definitions, regulations, and procedures of the University pertaining to his or her student status as set forth in the appropriate University of Lowell publications and bulletin.

Students who have questions about the interpretation or application of University academic policy should consult the dean of their college or the registrar.

BACCALAUREATE DEGREE POLICIES

Undergraduate programs which are offered by the University of Lowell lead to one of the following degrees: Bachelor of Arts, Bachelor of Fine Arts, Bachelor of Liberal Arts (continuing education program only), Bachelor of Science, Bachelor of Music, Bachelor of Science in Business Administration, Bachelor of Science in Industrial Management, Bachelor of Science in Engineering, Bachelor of Science in Engineering Technology (continuing education program only), and Bachelor of Science in Technology.

Bachelor of Arts Degree

Curricula leading to the Bachelor of Arts degree are designed to provide a broad, comprehensive education with many options for developing major and minor programs. These options are specified by each of the colleges offering Bachelor of Arts degree programs and are sufficiently flexible to satisfy the individual needs of students while also providing sufficient preparation in the major field for subsequent specialization at the graduate level. All Bachelor of Arts degree programs require completion of a major within the college in which the student is a degree candidate and (except as specified by policies concerning second majors) a minimum of 75 credits outside the major field. The following is a listing of major fields in which the Bachelor of Arts degree is presently offered by colleges of the University.

College of Liberal Arts

American Studies
Art
French
History
English
Modern Languages
Philosophy
Political Science
Psychology
Sociology
Spanish

College of Pure & Applied Science

Chemistry
Environmental Sciences

College of Management Science

Economics

College of Music

Music (General)

Bachelor of Science Degree

The Bachelor of Science degree is designed to provide students with a broad scientific education with specialized training in one or more of the basic sciences (e.g., biological sciences, mathematics, meteorology, etc.) or to combine a general education with a specialized applied program (e.g., health education, nursing, the administration of criminal justice, etc.). Curricula which are offered in areas of the pure and applied sciences and mathematics provide opportunities for major and minor program options but afford greater opportunities for major specialization than are permitted in comparable Bachelor of Arts curricula. All Bachelor of Science degree programs require completion of a major within the college in which the student is a degree candidate and a minimum of 50 credits outside the major field. The following is a listing of major fields in which the Bachelor of Science degree is presently offered by colleges of the University.

College of Health Professions

Health Education
Clinical Laboratory Sciences*
Nursing
Physical Therapy#

* Options available in Clinical Laboratory Sciences, Medical Technology and Exercise Physiology. (The option in Exercise Physiology will be available from September, 1987).

# Program terminates with the graduating class of 1990.

College of Liberal Arts

Public Service: Administration of Criminal Justice

College of Pure & Applied Science

Biological Sciences
Chemistry
Computer Science
Environmental Sciences+
Mathematics*
Meteorology
Physics#
Radiological Health Physics

+ Geology option available.

* Options available in Pure or Applied Mathematics, Computer Programming, and Statistics.

# Options available in Optics and Applied Physics.

Other Baccalaureate Degrees

Bachelor of Fine Arts, Bachelor of Music, Bachelor of Science in Business Administration, Bachelor of Science in Industrial Management, Bachelor of Science in Engineering, and Bachelor of Science in Technology degree programs have been determined by the requirements of specific career objectives and are subject to the recommendations of such professional associations as the National Association of Schools of Music and the Accreditation Board for Engineering and Technology. Course requirements for these professional degree programs are specified in terms of the total course of study and without reference to academic options which are available to students under Bachelor of Arts and Bachelor of Science degree programs. The Bachelor of Science in Engineering Technology and the Bachelor of Liberal Arts degrees are available as continuing education programs only.

GENERAL DEGREE REQUIREMENTS

University policy requires all degree candidates to comply with the following standards:

1. Mastery of at least one discipline, field of knowledge or applied professional area;
2. Competence in writing the English language;
3. An understanding of the substative structures of the primary modes of knowledge (humanities, social sciences, mathematics, and science); and
4. A familiarity with problems and issues of value and choice.

To qualify for University degrees, baccalaureate candidates are required to obtain minimum grade-point averages of 2.00 ("C") in their total courses of study, to present a minimum of 120 academic credits, to fulfill the minimum residency requirement which is designated for University day courses and for each major, to satisfy the regulations and academic standards of the colleges which exercise jurisdiction over the degrees for which they are matriculating, to complete all curriculum requirements specified by the college in which they are enrolled and department(s) in which they are majoring, and to complete the University core requirements.

University Core Requirements

The following core requirements are in effect for the class of 1987 and for all subsequent classes. University core requirements consist of the following:

1) an English composition requirement,
2) an area distribution requirement,
3) a human values requirement*, and
4) a physical education requirement, the course credits of which do not apply to minimum credit requirements for degrees.

* Required for the core if not satisfied by courses of a professional or major program.

English Composition Requirement (6 semester credits)

All students must pass a sequence of two courses totaling six semester credits in composition (College Writing I and II, normally taken in freshman year) unless they are specifically exempted in whole or in part by the English Department on the basis of a written proficiency examination.

Area Distribution Requirements (27-29 semester credits)

Area I	Social and Behavorial Sciences
Area II	Fine Arts and Humanities
Area III	Mathematics and Sciences

All students must pass a minimum of nine courses (a total of 27 to 29 semester credits) outside their major department according to the following distribution.* *Courses for which*

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* Students pursuing a double major, both of which are in a discipline specifically listed under Area I, II, or III are required to complete the area distribution requirement outside of one of their two major departments. Such students may not present courses for the distribution requirement which may be elected for either of their major departments..

a student has registered on a pass-no credit basis may not be counted toward the completion of the area distribution requirements of the University core curriculum.

1) A minimum of two courses and six semester credits must be presented in each of Area I and Area II, plus two additional courses (six semseter credits) selected from either or both of these areas.

   Total: six courses. 18 semester credits.

2) A student also must present a minimum of three courses (nine to eleven semester credits) in Area III; one course must be in a laboratory science (or its equivalent), a second must be in mathematics, and a third course shall be in either science or mathematics.

   Total: three courses, 9 to 11 semester credits.**

3) A student whose academic major falls in a discipline specifically listed under Area I, II, or III, or whose professional major is cognate with one of these disciplines, is exempted from the distribution requirement for courses in that area.#

4) A student must satisfy distribution requirements by passing courses selected from an approved list.##

5) In fulfilling the distribution requirement, a student is limited to a maximum of two courses in any one department. Additionally, a student is limited to two courses in literature, irrespective of departmental listing.

Human Values Requirement (3 semester credits)

All students are required to pass one human values core course which emphasizes the values and processess that lead to the making of ethical and humane decisions. Except for courses designed by departments to meet this requirement which are required for and restricted to majors only, a student shall satisfy this requirement by passing a course selected from an approved list.## Unless otherwise specified by a student's college or department, a course may simultaneously meet the human values requirement as well as another requirement in the student's curriculum. However, such a course cannot be counted twice in meeting the overall semester credit requirement for the curriculum.

Physical Education Requirement (2 semester credits)

All students must successfully complete one year of supervised physical activity. Students who fail to satisfy the requirement of the physical education program by the end of the freshman year must repeat failed courses until such time as they have passed them. Grades for physical education courses are awarded on a "pass-no credit" basis ("P" or "NC") and are not computed in cumulative averages. Students who have not passed the physical education requirement by the end of their senior year are advised that graduation will be denied until such time as the requirement is satisfied.

** Students who have passed specified mathematics courses and/or standard laboratory science courses in fulfillment of requirements for major areas which are cognate with Area III and who subsequently transfer to programs which are not cognate with Area III shall have such courses credited to the Area III requirement. The laboratory component must have been passed to satisfy the Area III laboratory science requirement.

The College of Liberal Arts requires that a student whose major(s) is (are) offered within the college, or whose primary major (in the case of students pursuing majors in more than one college) is offered within the college, complete the area distribution requirement as specified and no exemption, in whole or in part, is permitted to a student whose academic major falls within a discipline which is listed under Area I or II.

An approved list of courses available for the next semester will be published prior to registration for that semester.

Waivers of the physical education requirement are granted to students who participate in varsity athletics, marching band, and to students who have successfully completed military summer field training. A waiver will be granted to veterans who document their status with form DD 214.

Students who are physically unable to participate in activity classes may have the requirement waived upon written confirmation of limitation by a physician. The student must present this documentation to the Dean of the College of Health Professions *prior to the beginning of their senior year.*

Challenge Examinations for Physical Education

Students are permitted to demonstrate proficiency at an intermediate level or above in specified lifetime sports through an equivalency examination administered by the Physical Education Department. Students who have previously received credit for the sport are not permitted to take the challenge examination. One credit is awarded for each challenge examination that is passed. Examinations may be taken in the following sports: archery, badminton, bowling, golf, handball, raquetball, squash, swimming, weight training, and tennis.

Residency Requirements

All baccalaureate degree candidates must satisfy both general and major field residency requirements.

General Residency Requirements

All candidates for baccalaureate degrees, exclusive of categories 4 and 5 below, must complete 60 semester credits at the University of Lowell. In any event, all candidates for non-continuing education baccalaureate degrees must complete 30 credits of full-time study in University day courses. The following residency options apply, as specified, to candidates for baccalaureate degrees:

1) Complete three years in the University, earning not less than 90 credits (30 of which must be earned through full-time study in University day classes), and an approved junior or senior year program at another accredited baccalaureate institution, earning not more than 30 semester credits or the number of semester credits which is specified for juniors or seniors by those prescribed courses of study which are listed in the applicable issue of the *Bulletin of Undergraduate Studies*;

2) Complete an associate degree at the University of Lowell (continuing education) or at a Massachusetts Community College under the provisions of the Commonwealth Transfer Compact and complete the last two years at the University, earning not less than 60 credits (30 of which must be earned through full-time study in University day courses);

3) Complete up to the first two years in an accredited two-year institution, earning not more than 60 semester credits with grades of "C" (2.0 on a 4.0 scale) or better, and the remaining years in the University, earning not less than 60 semester credits (30 of which must be earned through full-time study in Univesity day courses);

4) Complete up to the first three years of a baccalaureate program in an accredited four-year institution earning not more than 90 semester credits, with grades of "C" (2.0 on a 4.0 scale) or better, and the remaining year(s) in full time study in University day classes, earning not less than 30 credits; or

5) Complete up to the first three years of a continuing education baccalaureate program at the University of Lowell and the remaining year(s) in full-time study in university day classes, earning not less than 30 credits.

The requirement of 30 semester credits of full-time study in University of Lowell day courses may not be satisfied through course eqivalency procedures. However, residency requirements over and above this requirement may be satisfied subsequent to admission to the University through these procedures.* Upon the approval of the appropriate college dean, up to 15 credits of the minimum day course requirement also may be satisfied through completion of day courses in the University of Lowell Summer School. Students who are interested in petitioning for application of day courses of the University of Lowell Summer School to the minimum day class requirement must file an academic petition with the dean of the college to which they have been admitted as degree candidates prior to enrolling for summer school courses.

Students who matriculate part-time for degrees under provisions of the Second Chance program must satisfy requirements in University day classes as specified (including the requirement specified below for the major) but may fulfill these requirements on either a full-time or part-time basis. An individual who has been admitted to day courses of the University as a non-matriculating (special) student is not considered a student in residence. If subsequently admitted as a matriculating student, such an individual must petition the college dean for recognition of non-matriculated courses. Up to 15 credits of non-matriculated day courses may be recognized for application to the minimum residency requirements of 30 credits of University day courses.

Residency Requirement for Major Fields

Each baccalaureate degree candidate must complete at least 15 credits in regular class work within major departments of the University for each major which is presented for a degree. Upon the approval of the appropriate college dean, the course requirement of 15 credits within major departments for each major pursued may be satisfied through satisfactory completion of day courses in the University of Lowell Summer School. Students who are interested in petitioning for application of day courses of the University of Lowell Summer School to the 15 credit major requirement must file an academic petition with their college dean prior to enrolling in summer school courses.

Dual Degree Program: Bachelor of Arts and Bachelor of Science in Engineering

Students who wish to pursue the dual degree program in the College of Liberal Arts and the College of Engineering must establish simultaneous matriculation in both colleges and designate candidacy for two degrees. The curricula for dual degree programs are approved by participating college faculties and must be completed as prescribed. It is therefore imperative that a student who wishes to pursue an approved dual degree program obtain a copy of the specified curriculum which enumerates the specific semester-by-semester course requirements.

Students interested in this program should direct their inquiries to the office of the Dean of the College of Liberal Arts or the Dean of the College of Engineering. Students who wish to pursue a second major should consult the regulation concerning the declaration of a second major which appears elsewhere in this publication under the heading "Major Field Requirements."

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* Cf. regulations which appear elsewhere in this publication under the heading "Course Equivalency Examinations." Note that specific restrictions apply to students who transfer to the University.

Language Requirement

Although the University does not require language proficiency, as such, for any degree, each faculty having jurisdiction over specialized program areas has the prerogative of specifying a level of language proficiency as a collateral requirement for major fields.

Note: effective with the entering freshman class in September, 1987, all candidates for the Bachelor of Arts degree in the College of Liberal Arts must demonstrate intermediate level language proficiency. Regulations governing this requirement are detailed under the heading "Language Proficiency Requirement" in the College of Liberal Arts section of this bulletin.

Students who are required to evidence intermediate proficiency and individuals who desire to present official evidence of language proficiency for purposes of employment or application to graduate schools may satisfy intermediate language proficiency through any one of the following options:

a. a score of "550" or above on a College Entrance Examination Board Achievement Test;

b. a score of "3" or above on a College Entrance Examination Board Advanced Placement Examination;

c. a satisfactory score in a proficiency test prepared and administered by the Language Department of the University of Lowell (preferably during the student's freshman year) and covering a reading knowledge of any one of the following languages: French, German, Greek, Italian, Latin, or Spanish;

d. passing two semester courses on the intermediate, second-year college level in a language previously studied in the secondary school and offered by the University of Lowell; or

e. passing a minimum of 12 semester credits in one language, the study of which is initiated at the University of Lowell.

Cooperative Education

The Cooperative Education Program integrates academic studies with productive work experience in business and industry and is available to all individuals whose major departments have agreed to permit their students to participate in an alternating schedule of study and work. Since students generally are placed in employment related to their academic fields of study, the Cooperative Education Program not only provides a source of income which may help students to defray their college expenses, but also tends to make classroom work more immediately relevant by clarifying career goals through personal experiences.

Full participation in the Cooperative Education Program ordinarily implies extension of the normal period of baccalaureate study to five years, entails three alternating working periods (fall, spring, and summer) with participating employers, and requires individual commitment to a 40 hour work week during assigned working periods. A maximum of three semester credits per working period (up to a total of nine credits) may be granted to participating students upon authorization of appropriate major departments. Depending upon departmental policies, these credits may satisfy unrestricted elective course requirements.

When on cooperative education assignment, a student remains registered at the University by means of required seminars and is required to pay student union and student activity fees. Additional information concerning the requirements for program participation may be secured from the office of cooperative education.

Undergraduate Classification

Irrespective of the provisions of specific curricula and the number of full-time semesters completed by students, the University determines class standing on the basis of total credits earned (including physical activities and AFROTC credits) and in accordance with the following scales:

Freshman standing	0-29 semester credits
Sophomore standing	30-59 semester credits
Junior standing	60-89 semester credits
Senior standing	90 or more semester credits (to graduation)

Maximum Period of Baccalaureate Study

Depending upon the nature of the subject and discipline, courses taken by a student may become obsolete for curricula of the University when they have been completed over a period of time which exceeds the customary period for baccalaureate study. Accordingly, University departments reserve the right to delete courses from a student's program of study when such courses have been determined to be obsolete for the curriculum in which the student is enrolled.

Ten full-time semesters is the maximum period which is permitted for continuous University matriculation unless special permission for additional semester enrollment has been granted by the dean of the college in which a student is enrolled as a degree candidate. A student who fails to complete degree requirements within ten full-time semesters may be dropped from the University when instructional resources render it necessary to establish limitations upon enrollments.

MAJOR FIELD REQUIREMENTS

Candidates for the Bachelor of Arts degree may not be required to take more than 45 credits in their major fields. Candidates for the Bachelor of Science degree may not be required to take more than 60 credits in their major fields. However, candidates for either degree may elect to take additional courses in the major beyond the specified maximum providing that such additional courses are not presented for the minimum degree requirement of 120 credits. Accordingly, major credits which exceed the specified maximum will raise by an equal amount the number of minimum credits which are required for the Bachelor of Arts or Bachelor of Science degree.

Declaration of Major

Students who have declared a major at the time of their admission to the University are officially enrolled in the college in which their designated major is offered and are referred by the college dean to the chairperson of the designated major for assignment of a faculty advisor. Although the University does not require students to declare their major fields until the semester in which they will complete 60 semester credits, several colleges require an earlier declaration. In any event, an early decision by students will greatly facilitate the selection of appropriate prerequisite courses for major fields and accordingly will reduce the possibilities of time-consuming errors in judgment. Students enrolled in the College of Pure and Applied Science are strongly encouraged to declare their major fields by the end of the freshman year. Students contemplating majors in chemistry or environmental sciences should initiate prerequisite course work immediately upon entrance to the College of Pure and Applied Science and should make a declaration of major at this time or prior to the end of the freshman year. Students in the College of Health Professions must declare a major upon the completion of 45 semester credits. Students admitted to the College of Engineering must make a declaration of major at the time of admission. Additional course work beyond the minimum degree requirement and extension of the normal four-year period of study may be expected when individuals make a declaration of major later than recommended above.

Students who make no declaration of major prior to the end of their sophomore year are listed as undeclared students for their first two years. Individuals who wish to designate a major which is offered by the college in which they are enrolled as undeclared students must secure the signature of the appropriate department chairperson (or the chairperson of the committee which exercises jurisdiction over an interdepartmental major) on a declaration of major form and must file the completed form with the office of the registrar. Individuals who wish to designate a major which is not offered by the college in which they are enrolled as undeclared students must file an approved form for intercollegiate transfer and declaration of major with the office of the registrar. This form requires the signatures of the dean of the college to which the student transfers and the appropriate department chairperson.

Undeclared students are advised that openings may be limited or unavailable in some programs and that differential admissions criteria may be applied to program or college applicants when staffing or facilities render it necessary to establish limitations upon enrollments.

Declaration of Second Major

Students who wish to declare a second major should consult with their college dean to determine if a second major can be completed within specified degree requirements or will require additional study beyond the minimum degree requirements and extension of the regular period of baccalaureate study.

Students who wish to declare a second major in the college in which they are enrolled as degree candidates ordinarily may do so by filing an approved declaration of second major with the office of the registrar. Students who wish to declare such a major in another college of the University may do so only when regulations of that college and the college in which they are enrolled as degree candidates both permit. Such declarations require the approval of both college deans. Students who are permitted to carry two majors are assigned an advisor in each major department.

Individuals who are matriculating for the Bachelor of Arts degree may not count more than 63 credits in the two academic majors combined toward the minimum degree requirement of 120 credits. Students who present more than 63 credits in the two majors combined may not present less than 57 semester credits outside the two major fields in satisfying the minimum degree requirement of 120 credits. Accordingly, students who present more than 63 credits in the two majors combined must present a number of credits beyond the minimum degree requirement of 120 credits which is equal to the number of credits by which they exceed the combined major credit maximum.

Except as noted above under the heading "Dual Degree Program," students who elect academic majors in more than one college are candidates for one degree only; and they are considered to be degree candidates in the college of their initial major unless they indicate to the contrary by filing for intercollegiate transfer at the time they make a declaration of second major. Accordingly, a student who pursues academic majors in two colleges is subject to all degree requirements as specified by the college of his or her initial academic major and is subject only to major course requirements (including collateral and prerequisite courses for the major) as specified by the department of his or her second academic major. Individuals who pursue double majors within different degree programs will receive the degree which is designated for their initial academic major unless they have filed for intercollegiate transfer when they filed a declaration of second academic major. Professional programs in business administration, engineering, health education, clinical laboratory sciences, nursing, physical therapy, industrial management, industrial technology, and Bachelor of Music programs may be designated as degree majors only. Although students in these programs may be permitted to pursue a second major in an academic field which is offered by another college, they are subject to all degree requirements as specified by the college for the professional major.

Change of Major

Once students have begun a program of major studies, they may change their major field only by filing an approved change of major form with the office of the registrar. Students who make substantial changes in their plans of study after the beginning of the sophomore year, regardless of major, ordinarily will find it impossible to complete degree requirements within the normal four-year period of study and may also find it necessary to redesignate their choice of degree. Students who have been placed on academic warning should review their choice of major and should contemplate a change of program.

Change of Major within College of Enrollment

Students who wish to change their declarations of major within the college in which they are enrolled as degree candidates are required to file an approved change of major form with the office of the registrar. This form requires the approval of the chairperson of the major department to which the student desires to transfer and should be filed by November 1 for spring semester transfer and by April 1 for fall semester transfer in order to insure proper advising during the periods of fall and spring preregistration. Filing after the recommended dates may be permitted by the chairperson of the department having jurisdiction over the new major. Students anticipating a change of major may drop irrelevant courses if applicable University rules permit (Cf. "Withdrawal through the 40th Class Day" and "Reduced Load Status"). *The symbol "X" may not be assigned to courses which are dropped after the 40th class day because a student intends to change a major.*

Change of Major with Intercollegiate Transfer

Students desiring to transfer from a baccalaureate continuing education program to a baccalaureate day program, to transfer from a baccalaureate day program* to a baccalaureate continuing education program, or to drop a major which is offered by the college in which they are matriculating and to add a major which is offered by another college of the University must apply for intercollegiate transfer.

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* Continuing education students transferring to day college programs should refer to policies under the heading "Residency Requirement" for specification of the number of credits which must be completed in regular day classes.

An individual seeking an intercollegiate transfer must file an academic petition and a transcript with the chairperson and dean having jurisdiction over the program to which transfer is desired. Following endorsement by both the chairperson and the dean, this form must be filed with the office of the registrar *by November 1 for spring semester transfer, and by April 1 for fall semester transfer. Individuals petitioning for intercollegiate transfer are required to satisfy the admissions requirements of their desired college and program and, irrespective of any initial favorable decision concerning such petition, they will not be permitted to transfer if they have been suspended from the University after they have been accepted for transfer.*

Individuals seeking transfer from one college to another are advised that openings may be limited or unavailable in some programs, that differential admissions criteria may be applied to program or college applicants when staffing or facilities render it necessary to establish limitations upon enrollments, and that the completion of degree requirements within the customary four-year period may not be possible since the correction of deficiencies cannot always be accommodated within the schedule of course offerings.

The official date of intercollegiate transfer is the first day of the semester following approval of a student's application. Since course preregistration is conducted prior to the official date of transfer, students should make immediate arrangements for pre-registration counselling with the dean of the college to which they will transfer. Subsequent to approval of a student's application for transfer and prior to the official date of transfer, the college dean shall review the academic record of the student to determine the applicability of previously completed courses to the requirements of the college and, if appropriate, the new major.

The dean shall provide the student and the office of the registrar with a listing of courses not applicable to the college or the new major and shall authorize their deletion from the student's cumulative grade-point average. Irrespective of grades received, all courses which may not be applied to minimum college or program requirements for degrees shall be deleted from the student's cumulative grade-point average. For example, nursing courses are not applicable to curricula of the College of Liberal Arts and a student who has completed such courses will have them deleted from his or her cumulative average upon transfer to the College of Liberal Arts. Students who subsequently transfer to another college within the University, or who return to the college from which they have previously transferred within the University, shall have their academic records again reviewed and appropriate courses shall be reinstated to the cumulative average and inappropriate courses shall be deleted. *No student shall be permitted more than two intercollegiate transfers.*

MINOR AREA REQUIREMENTS

The requirements for minors are established by University departments or by interdisciplinary committees. No minor program may consist of less than 18 semester credits in the minor field nor more than 24 semester credits. At least six credits must be completed at the upper-division course level for all minor studies. Students are advised that an aggregation of courses which total 18 or more credits does not constitute a minor field. Specific options for minor programs will depend on the major field which a student has elected to pursue and collateral course requirements which have been specified by major departments. Although minor programs generally may be elected without specific authorization of departments offering such programs, some minors do require such authorization.

In any event, individuals who are interested in electing a minor program should consult the relevant section of this publication for curriculum requirements and prerequisites. Notation of a minor program is not made on the student's permanent record card until all degree requirements have been satisfied and the office of the registrar has been notified by the college in which the student has matriculated concerning the completion of minor programs. Courses taken for the minor may not be applied to core area requirements. A course which is specified as a requirement for both a student's major and minor will satisfy both requirements, as stated, but course credits may not be counted more than once and may be applied to one category of a student's program of studies only.

COURSE EQUIVALENCY EXAMINATIONS

The University recognizes two types of course equivalency for which credit is awarded. These are (1) CLEP examinations, and (2) departmental examinations. Restrictions, where applicable, are noted below.

Subject to specified policies of academic departments, unusually qualified degree candidates are given the opportinity to demonstrate their special competencies and to receive University credit for such competencies through established course equivalency procedures without having to fulfill classroom or faculty course requirements. Matriculating students may demonstrate their special competencies through subject examinations of the College Level Examination Program and through departmental equivalency examinations.

Credits which are granted through course equivalency procedures are noted on the student's permanent record card. However, no grades for equivalency examinations are recorded and such examination credit as may be granted is not computed for determining grade-point averages.

The purpose of course equivalency procedures is to provide credit for existing competencies—that is, those competencies which students possess prior to their applications for equivalency credit and prior to their registration for a University course. *Students may not receive credit for a specific proficiency examination if they have registered at the University in the course which that examination represents, if they have previously received a University grade for that course or a course in sequence above the course for which they wish to take the examination, or if they have previously attempted an equivalent course at another institution.* Credit for general examinations of CLEP may not be granted to students after their admission to the University as matriculating students. University departments reserve the right to refuse the granting of credit by examination for those courses which are presented by a student for his or her major(s) and to deny recognition of previously granted credit for students who, prior to their declaration of major field, have received equivalency credit in the subsequently declared major.

Subject to the additional limitations of the college and program in which the student is enrolled, the maximum number of credits which a matriculating student may earn through course equivalency procedures (including advanced placement credits, CLEP subject examinations, and departmental equivalency examinations) is 42 semester credits. Students who have transferred to the University may not apply for equivalency credit in excess of a number which is determined by subtracting all course equivalency and transfer credits which are accepted by the University from the maximum of 90 credits which is permitted for both transfer and equivalency credit. Nor may transfer students present equivalency credits in fulfillment of the major field residency requirement of 15 credits in University courses or the general residency requirements of 30 credits in University day courses (Cf. "Residency Requirements").

College Level Examination Program (CLEP)

Students who are interested in taking subject examinations of the College Level Examination Program should secure petition forms from the office of the registrar which will permit matriculating students of the University to arrange for administration of CLEP tests. Approved forms must be filed with the office of the registrar. Application to take approved subject examinations of the College Level Examination Program may be made at the office of continuing education or other CLEP testing centers. CLEP tests are administered at the University during the third week of each month. Course credit through the subject examinations of CLEP will be granted only if an examination has been approved by an individual's faculty advisor and the chairperson of the department which offers the course for which the CLEP test is a substitute and the score attained by the individual is equal to or better than the minimum score for an examination specified in the table below.

Although students are advised to secure the above authorization prior to taking a CLEP test in order to avoid rejection of a request for credit after a test has been taken, such authorization may be solicited after completion of a test. CLEP tests in subjects not listed below will not be recognized for University credit. The following is a list of CLEP tests for which credit will be granted.

CURRENT TESTS	**Minimum Score for Awarding Credit**	**University Credits Granted**
Accounting, Introductory	47	6
Afro-American History	49	3
American Education, History of	46	3
American Government	47	3
American History	46	6
American Literature	46	6
Biology, General	46	6
Business Law, Introductory	51	3
Calculus with Elementary Functions	47	6
Chemistry, General	47	6
College Algebra	45	3
College Algebra-Trigonometry	45	3
College Composition	47	3
College French (Levels 1 and 2)*		
Second Semester	41	6
Fourth Semester	53	12
College German (Levels 1 and 2)*		
Second Semester	40	6
Fourth Semester	48	12
College Spanish (Levels 1 and 2)*		
Second Semester	41	6
Fourth Semester	50	12
Computers and Data Processing	47	3
Computer Programming		

* The College of Liberal Arts does not recognize and will not award credit for CLEP tests in a foreign language offered to satisfy the language proficiency requirement. Refer to "Language Requirements" in Liberal Arts sections of this bulletin for complete statement of college policy.

Elementary—FORTRAN IV	48	3
Educational Psychology	46	3
English Literature	46	6
Human Growth and Development	45	3
Literature, Analysis and Interpretation of	49	3
Macroeconomics, Introductory	48	3
Microeconomics, Introductory	47	3
Psychology, General	47	3
Statistics	49	3
Tests and Measurement	46	3
Trigonometry	50	3
Western Civilization	50	6

Departmental Examinations

Students who are interested in taking departmental examinations may obtain applications for such examinations from the office of the registrar at any time during the fall and spring semesters, but they must initiate the application process in sufficient time to permit the completion of examinations and the processing of examination results prior to the final deadline for filing course grades during the semester in which they are examined. Applications for departmental course-equivalency examinations are filed with the chairperson of the student's major department, the chairperson of the department in which the examination is to be administered, and the faculty examiner.

Students may not repeat departmental equivalency examinations and, except for documented medical reasons or personal emergencies, they may not reapply for such examinations in the event that they fail to keep an examination appointment. Examinations must be wholly or substantially written unless the nature of the course makes more appropriate an oral or performance examination. Departments may authorize instructors to administer end of semester examinations which are scheduled during the final examination period when such examinations are adequate measures of total course requirements. After the student has completed an authorized examination, the faculty examiner must file his or her recommendation for course credit with the office of the registrar by the final deadline for filing semester grades.

ACADEMIC HONORS

Academic honors are of three types: University honors, honors in major fields, and dean's list (semester honors). Students enrolled in all colleges may qualify for University honors and the dean's list. Honors in major fields are available at the option of the major departments.

University Honors

The University recognizes graduates who have attained exceptional scholastic distinction. To be eligible for such recognition a student must achieve a minimum grade point average of 3.00 for all courses completed at the University and must have earned a minimum of 60 semester credits at the University as upperclass students. Additionally, the record of each student must qualify him or her for the percentile distributions cited below as applied by each college to its total number of graduating students.

Summa Cum Laude	99th through the 98th percentiles
Magna Cum Laude	97th through the 90th percentiles
Cum Laude	89th through the 75th percentiles

University honors are officially entered on the permanent record cards of students.

Honors in Major Fields

In addition to honors which are awarded by the University, honors in major fields may be awarded by the colleges in which students are enrolled or (in the case of continuing education students) by the colleges which exercise academic jurisdiction over the program in which they are enrolled. Recommendations for such honors are made by the faculty of the student's major department (or by interdisciplinary committees which exercise academic jurisdiction over the student's major studies) for outstanding achievement in the major field. In order to qualify for such honors, the student must fulfill the following requirements:

1. Complete a minimum of 24 credits in the major field at the University of Lowell;
2. Fulfill any honors requirement as specified by colleges, departments, or interdisciplinary committees in the major field; and
3. Achieve a grade-point average as specified below.
   a. High Honors: 4.00 in all courses which are taken in the major field at the University of Lowell;
   b. Honors: 3.50 to 3.99 in all courses which are taken in the major field at the University of Lowell with no course grade in such courses less than "B".

Honors in the major field are noted on the permanent record cards of students.

Dean's List (Semester Honors)

At the end of the fall and spring semester, the dean of each college issues a list of students who have achieved distinguished semester records. This list recognizes students who have completed full-time programs (at least 12 credits of which must have been qualitatively graded) with no grade less than "B" or "S" (in the case of courses graded Satisfactory or Unsatisfactory).

AWARDING OF DEGREES

The University awards degrees three times a year: 1) in June for students completing degree requirements during the spring semester, 2) in October for students completing degree requirements during the summer term, and 3) in February for students completing degree requirements during the fall semester.

Programs of Study and Declarations of Intent to Graduate

In order to qualify for the award of a University of Lowell degree, all students are required to file with their advisor a copy of their final semester course registrations (including notification of course withdrawal) and an accurate account of courses taken, grades received, and changes of contemplated programs of study. Deadlines for conferring with faculty advisors concerning the completion of degree requirements and for filing final programs of study and declarations of intent to graduate with college deans are specified by the University calendar.

Each college has adopted a program of studies form which best reflects the nature of its degree programs. Forms which are employed by the College of Liberal Arts and the College of Health Professions have been standardized and designate three areas: University core requirements, major requirements, and collateral programs (second majors, minors, and unrestricted elective courses).

Credits for each course may be counted only once in a student's program of studies form and may not be counted for more than one category of the program of studies. Courses and credits in the human values requirement of the revised University core curriculum may be used to fulfill this requirement and another requirement in the student's curriculum but may not be counted twice in satisfying the overall credit hour requirement for the curriculum. A course which is specified as a requirement for both a student's major and minor will satisfy both requirements, as stated, but course credits may not be counted more than once and may be applied to one category of a student's program of studies only.

At the end of the semester following the filing of a declaration of intent to graduate, the college dean verifies course completions and required cumulative and major averages. The names of students who have satisfied all degree requirements are then forwarded to the appropriate college faculty for endorsement and, finally, to the office of academic affairs, which orders appropriate diplomas for conferral at graduation. *Students who unofficially complete all degree requirements and fail to file a declaration of intent to graduate or a program of studies shall not be recommended to the office of academic affairs and the conferral of the degree shall be delayed until an approved declaration has been filed.*

Graduation Exercises

Graduation exercises are held once a year at the end of the spring semester. Undergraduates who have completed requirements during the preceding fall semester, who complete degree requirements during the current spring semester, and who anticipate completion of degree requirements during the next immediate summer term are permitted to attend commencement exercises. Although the names of all such students are listed in the commencement booklet, diplomas are awarded only to students who have completed all degree requirements. Attendance at graduation exercises is not compulsory, but all seniors are required to pay the specified graduation fee, which covers the cost of the diploma, academic attire, and incidental graduation expenses. Students who do not elect to attend commencement ceremonies may not be granted a refund of the commencement fee. *An individual who wishes to receive a diploma by mail must file a corrected address with the office of the registrar if he or she anticipates moving from a previously reported permanent address.*

Ordering of Diplomas

Diplomas are ordered only when students have completed programs of study, have filed declarations of intent to graduate, and have been certified by colleges as having completed degree programs. Mere presence on campus for four or more years does not qualify a student for a diploma. Diplomas are awarded to students who wish to attend University graduation ceremonies or may be secured in person from the office of the college dean. Individuals who wish to submit verification of degree completion to employers or to graduate schools during the period between the end of their final grading period and the awarding of diplomas may obtain a letter of completion from their college dean. Duplicate diplomas are not issued for any reason.

GRADING POLICIES

The University employs both a qualitative grading system to designate student performance in courses and non-qualitative course notations to designate special enrollment provisions or course statuses.

Qualitative Letter Grades

The following qualitative letter grades are employed by faculty members to characterize the quality of a student's work in a course: “A”, “AB”, “B”, “BC”, “C”, “CD”, “D”, and “F” and respectively carry quality points of 4.00, 3.50, 3.00, 2.50, 2.00, 1.50, 1.00, and 0.

‘‘A’’	designates that the work done by the student is superior and is of the highest honors quality;
‘‘AB’’	designates that the work done by the student is less than superior but is completed with the level of distinction which is higher than the basic honors level;
‘‘B’’	designates that the work done by the student is of basic honors quality;
‘‘BC’’	designates that the work done by the student is less than honors quality but is better than satisfactory;
‘‘C’’	indicates satisfactory work which conforms to the general expectations of the University for baccalaureate study;
‘‘CD’’	indicates that the work done by the student is less than satisfactory and below graduation standard but is better than the minimum requirement for passing a course;
‘‘D’’	indicates work which meets the minimum requirement for passing a course;
‘‘F’’	designates course failure.

Non-Qualitative Course Notations

The following symbols are used to designate special enrollment provisions or course statuses and do not affect the student's academic average:

‘‘P’’	designates completion with credit of an unrestricted elective or physical activities course which was taken on a “pass-no credit” basis;
‘‘NC’’	indicates failure of an unrestricted elective or physical activities course which was taken on a “pass-no credit” basis;
‘‘S’’	designates satisfactory completion of a practicum experience course with a final course grade of “C” or higher;
‘‘U’’	indicates unsatisfactory performance in a practicum experience course with a final course grade of less than “C”;
‘‘I’’	indicates a course which has not been completed;
‘‘AU’’	designates that the student has registered for a course on an “audit” basis and has maintained an attendance record throughout the semester which is sufficient to warrant an official recognition of course attendance;

"W" designates student withdrawal from the University prior to the 41st class day of a semester or from a course during the period from the 10th to the 40th class day;

"X" designates student withdrawal after the 40th class day of a semester for administratively approved reasons of an emergency or medical nature; and

"Y" designates administrative dismissal for other than academic reasons.

Policies Governing Non-Qualitative Course Notations

Special policies govern student registration for courses on other than a qualitative grading basis and for withdrawing from courses without the assignment of course grades. The following sections describe these policies and explain other special provisions which govern the assignment of non-qualitative course symbols.

Audited Courses

A student may enroll in credit courses as an auditor with the approval of the instructor which must be obtained within the first ten class days of the semester. Forms and instructions for registration as an auditor may be obtained from the office of the registrar. No charge is levied on full-time students for audited courses. No credit or grade will be recorded for an audited course, but the symbol "AU" may be listed on the permanent record card at the request of the course instructor when he or she judges that the student has exhibited satisfactory attendance. A change from auditor to credit status, or from credit status to auditor, may not be made after the deadline for adding a course.

Credit may not be earned in courses which have been audited except by re-enrollment in and completion of the course with a passing grade. Students who have audited a course subsequently may not earn credit in the same course through tests of the College Level Examination Program or through other authorized examination procedures for course challenge.

Incompleted Courses (Letter Symbol of "I")

The letter symbol "I" (incomplete) is a temporary notation which is assigned for incomplete work in courses when the records of students justify the expectation that they will obtain a passing grade but for emergency reasons they have been absent from the final course evaluation. Any missed final examination or other final course evaluation requires a student explanation within 48 hours so that the instructor can file the proper course notation with the office of the registrar. *A student who has evidenced an unsatisfactory course record, who has failed to complete a major portion of an instructor's course requirements, or who fails to provide an instructor with a satisfactory reason for absence from a final examination or final course evaluation within the specified 48 hour period MAY NOT be assigned the letter symbol "I".* Responsibility for making arrangements with an instructor to complete all outstanding course work rests entirely with the student, who must complete all course work in sufficient time to permit an instructor to file a final course grade no later than one month after the date on which the succeeding semester begins.

Instructors who file letter symbols of "I" also must file an end of course letter grade which will be assigned in the event that incompleted course work is not made up by the student prior to the established deadline. At the end of the official make-up period (or, in the event of a substantiated student emergency, at the end of an extended make-up period), the registrar will convert the temporary notation of "I" to the appropriate permanent symbol. This permanent notation will be one of the following: 1) a letter grade which has been filed by an instructor during the grading period of the previous semester to designate the final course standing of a student who has failed to make up incompleted course requirements, 2) a letter grade which is filed by an instructor at the end of the make-up period to designate the final course standing of a student who has made up incompleted course requirements, or 3) the letter symbol of "X" which the dean of the college in which the student is enrolled as a degree candidate may authorize to designate that a student has withdrawn from the University after the end of the semester for documented medical or personal emergency (Cf. "University Withdrawal After the End of the Semester").

Limited extensions of the make-up period may be granted to students for serious medical reasons and for documented personal emergencies. Requests for such extensions are approved by the dean of the college in which students are enrolled as degree candidates *and must be filed no later than one calendar week preceding the established deadline for instructors to submit final grades for incompleted courses.* Except for extraordinary circumstances acceptable to a college dean, the maximum period for which an extension may be granted is the last scheduled class day of the semester following the assignment of "I" notations.

Pass/No Credit (Pass/Fail) Registration

Students may elect to register on a pass-no credit basis for a maximum of four unrestricted elective courses. Permission of the instructor, which must be obtained within the first ten class days of the semester, is required. A student may not change his or her enrollment status from letter grade to pass-no credit or from pass-no credit to letter grade after the established deadline for adding a course. A pass-no credit course cannot be presented in fulfillment of University core requirements, major programs, minor programs, or specifically designated courses (collateral requirements) of an established curriculum. A grade of "P" indicates that a student's performance merits an evaluation of "D" or better. "NC" indicates that a course has been failed but that such failure is without prejudice to the student's cumulative average. Although appropriate credits are granted to students when grades of "P" have been assigned, these credits are not qualitatively weighted and hence do not affect a student's academic average. The entry "NC" will not keep an otherwise qualified student from dean's list recognition.

Satisfactory/Unsatisfactory Course Registration

Certain courses (e.g., practicum experiences, advanced seminars, and directed studies) may be graded as satisfactory or unsatisfactory. A grade of "S" indicates that a student's performance merits an evaluation of "C" or better. "U" indicates a course evaluation of less than "C". Although appropriate credits are granted to students when grades of "S" have been assigned, these credits are not qualitatively weighted and hence do not affect a student's academic average. A grade of "U" indicates that attempted course credits have not been granted and is awarded without prejudice to a student's cumulative average.

Course Withdrawal

"W" and "X" are administrative symbols which indicate that a student has been authorized to withdraw from courses or from the University. These symbols, which are entered upon the student's permanent record card without prejudice, may be authorized only in accordance with established policies of the University *and only upon student request.*

Course Withdrawal Through the 40th Class Day

Students who desire to withdraw from courses with notations of "W" during the period from the 11th to the 40th class day of a semester must secure the signatures of advisors and course instructors on official course drop cards and must file these forms with the office of the registrar no later than the 40th class day. Students who do not complete the process of withdrawal by the 40th class day will not be assigned course notations of "W", will be subject to all instructor course requirements, and will receive final course grades. Since it may take several days to secure necessary faculty signatures, and since such unforeseen circumstances as late trains, automobile breakdowns, and faculty absences unexpectedly may extend the period during which a student has planned to complete the withdrawal process, a student who delays his or her course withdrawal until the end of the withdrawal period may discover that it is impossible to comply with the withdrawal deadline of the 40th class day.

When course withdrawal will result in a course load of less than 12 credits, authorization of the student's college dean and the University registrar is required. Students who withdraw from all courses are required to withdraw from the University. Students receiving benefits from the Veterans Administration are not permitted to reduce their course loads below the full or part-time levels which they have reported to the Veterans Administration.

Course Withdrawal After the 40th Class Day

Course withdrawal after the 40th class day of a semester ordinarily requires withdrawal from the University but partial withdrawal may be authorized for reason of extended illness or critical personal emergency.

1. The student must present an academic petition to the dean of the college in which the student is enrolled which identifies the course(s) from which the student seeks to be withdrawn.
2. The student must present appropriate, verifiable documentation which is corroborative of the reason for withdrawal advanced on the petition.
3. Under no circumstances will partial withdrawal be authorized merely because a student anticipates a low or failing grade in the course or because of the presumed effect of a low or failing grade on the student's cumulative grade point average.
4. The student who fails to complete all of the course withdrawal procedures before the first day of the final examination period will be denied permission to withdraw from a course and will be graded.

Students receiving benefits from the Veteran's Administration are not permitted to reduce their course loads below the full or part-time levels which they have reported to the Veterans Administration.

Grade Changes

At the end of each semester, the office of the registrar mails a grade report to each student. This report constitutes official notification of grades received. All course grades become a part of the student's official record upon instructor assignment and may not be changed except as specifically provided by University procedures. Corrections of grade-point averages automatically are authorized when erroneous grade reports are corrected by instructors and when specific courses are deleted from grade-point averages under provisions of University regulations governing repeated failed courses, change of enrollment status as an intercollegiate transfer within the University, and expiration of degree credits.

Students who believe that a mistake has been made in assigning or recording a course grade should notify instructors as soon as possible after receiving their grade reports but in no case at a time later than the deadline established for making grade corrections. The deadline for instructors to correct an erroneous grade report is one calendar month from the beginning of the semester following the filing of an erroneous grade. Changes of grades other than the filing of grades for incompleted courses require the endorsement of the appropriate college dean. Grade changes may not be made on a student's permanent record card after the deadlines cited above unless such changes have been authorized by appropriate college deans prior to the expiration of the correction deadline. Accordingly, students who experience difficulty in contacting faculty members for the purpose of questioning assigned grades should consult the appropriate college dean prior to the expiration of the correction deadline.

ACADEMIC STANDING

Academic standing and eligibility for a degree are determined by the quality of the student's course work.

Determination of Academic Standing

To ascertain the student's academic standing, the University uses a point system, each qualitative grade having an equivalent numerical value. A grade of "A" has a value of 4.00, a grade of "AB" a value of 3.50, a grade of "B" a value of 3.00, a grade of "BC" a value of 2.50, a grade of "C" a value of 2.00, a grade of "CD" a value of 1.50, a grade of "D" a value of 1.00, and a grade of "F" a value of 0. Quality points are computed by multiplying the course credit by the numerical value of a qualitative grade assigned. For instance, a three credit course completed with a grade of "BC" would carry 7.50 quality points (3 x 2.50). The grade-point average is obtained by dividing the total number of quality points earned by the total number of credits completed and graded with those qualitative grades which are cited above.

Each student is subject to the following table of grade-point requirements for the specified numbers of attempted course hours. The cited grade-point averages are minimum University requirements. Individual colleges or departments may establish higher requirements.

Qualitative Requirements for Retention

Course Hours attempted*	Grade-Point Averages Satisfactory Standing+	Grade-Point Averages Academic Warning+	Grade-Point Averages Suspension Category
12-30	1.500	1.400-1.499	1.399 or below
31-45	1.600	1.500-1.599	1.499 or below
46-60	1.700	1.600-1.699	1.599 or below
61-75	1.800	1.700-1.799	1.699 or below
76-90	1.900	1.800-1.899	1.799 or below
91-graduation	2.000	1.900-1.999	1.899 or below

* Included in course hours attempted are all course credits which have been granted (including credits awarded through transfer and challenge by examination, course credits which have been awarded with qualitative letter grades, and credits attempted with notation of "Incomplete" or with nonqualitative grades of "P" and "S") and all hours of course work which have been failed with the qualitative letter grade of "F". Courses which have been failed and which carry the non-qualitative symbols of "U" and "NC" are not included in the computation of course hours attempted.

+ Specified grade-point averages are computed solely on the basis of those courses attempted at the University of Lowell which have been qualitatively evaluated with the following letter grades: "A", "AB", "B", "BC", "C", "CD", "D", and "F".

Review of Academic Records

For the purpose of determining the academic standing of students, the office of the registrar evaluates all student records at the end of each semester and makes appropriate notation of unsatisfactory academic status ("Academic Warning" or "Suspension Category") on student permanent record cards. Freshmen students are initially evaluated for retention purposes at the end of the semester in which they have attempted their first 12 credits at the University. Transfer students are evaluated for retention purposes as follows.

1. Transfer students who left their previous institutions in good standing are initially evaluated for retention purposes at the end of the semester in which they have attempted their first 18 credits at the University.
2. Transfer students who have been dismissed from their previous institution for academic reasons shall be reviewed at the end of their initial (probationary) semester for satisfaction of the requirements of their probation.
3. Students who have completed at least one full semester at the University, have transferred to another institution (whether a compact or a non-compact institution), and then return to the University of Lowell shall be evaluated for retention purposes at the end of the first full-time semester which immediately follows their return to the University.*

Entering freshmen and transfer students who are permitted to initiate their University studies with summer school day courses should note that credits attempted in University summer sessions are included in calculations for the fall semester. Entering students who have initiated their University studies in authorized summer school courses are not permitted to invoke the regulation concerning course repetition for the purpose of grade substitution prior to the initial evaluation of their records for retention purposes. The records of matriculated students in the Second Chance program are initially evaluated for retention purposes at the end of the semester in which they have attempted their first 12 credits of matriculated study. Subsequent to initial evaluations for retention purposes, the records of all full-time students (including probationary students) are evaluated at the end of each semester.

Grades for courses taken in summer sessions at the University of Lowell are normally computed into the cumulative grade point average at the end of the succeding fall semester. However, students who have completed at least one full-time semester at the University and who take summer school courses may petition for recomputations of their cumulative grade point averages at the end of the summer sessions, provided that:

1. there are no outstanding grades of "I" (incomplete) on the student's record at the time when such computations are made, and
2. the petition for such recomputation is filed with the University Registrar by July 15 or the first day of Summer Day Session II, whichever is later.

Academic Warning

A student whose cumulative grade-point average falls below the minimum University requirements for course hours completed by no more than 0.10 is immediately placed on academic warning. (See retention table above). A full-time student who has been placed on academic warning and who has not attained satisfactory standing by the end of the following full-time semester is suspended from the University. A matriculated student in the Second Chance program who has been placed on academic warning is required to achieve satisfactory standing by the end of the semester in which the next 15 credits have been attempted following his or her notification of academic warning. Students who have been placed on warning that their academic achievement is deficient should consider the desireability of declaring another major or of transferring to another college within the University. Students on academic warning are prohibited from holding student offices or running for elective office and from representing the University in athletic or other activities.

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* Students who have transferred to a compact institution and have earned an Associate of Arts or Associate of Science transfer degree will be evaluated for retention purposes at the end of the semester in which they have attempted their first 18 credits at the University.

Academic Suspension

A full-time student, reduced-load student, or matriculating student in the Second Chance program whose cumulative grade-point average at the end of any semester falls below the minimum University requirement for course hours completed by more than 0.10 is immediately suspended. A student who has been suspended is prohibited from enrolling in any program of the University, including credit courses of University continuing education and summer sessions. University credits earned in violation of this prohibition will not be honored if and when the student seeks probationary readmission to the University.

Academic Probation

A student who has been suspended from the University is entitled to apply to the office of admissions for readmission as a probationary student after a one semester absence from the University, not including summer sessions, in accordance with procedures enumerated under the admission policy heading “Probationary Readmission”. Students who are readmitted on probation will receive a letter from the college academic standards committee which will specify the conditions of their probation, their probationary courses (not less than 12 credits for other than matriculated Second Chance students), and the semester average which they must achieve during their probationary semester in order to achieve satisfactory academic standing. Probationary students are prohibited from holding student offices or running for elective office and from representing the University in athletic or other activities.

A student who achieves the *required semester average* during his or her probation is automatically reinstated as a student in satisfactory academic standing. A probationary student whose semester average falls below the required semester average by no more than 0.10 may be granted an extension of the probationary period for one additional semester. Such extension of probation, if granted, will be made by the appropriate academic standards committee during the period between semesters. Students who are granted such extensions will be notified in writing prior to the beginning of classes for the following semester that they have been granted an additional semester to achieve satisfactory academic standing.

Students readmitted on probation may not withdraw from any course unless they withdraw from the University with permission of the college dean for reasons of emergency or for medical reasons. A probationary student who withdraws from any course cannot satisfy the conditions of his or her probation and will be expelled from the University at the end of the current semester of enrollment.

Probationary students who receive course evaluations of “I” (incomplete) and who fail to make-up their work prior to the beginning of the next semester are advised that they may not qualify for extension of their probation and may not register for nor attend University courses (including continuing education courses) until such time as a final determination of their status has been made. Probationary students who have received permission of a college dean to extend their make-up period should understand that such extension does not waive the requirement for a final determination of academic standing which is based upon grades for all probationary courses.

Students who have enrolled in University summer school and/or continuing education courses after they have been notified by the office of the registrar that they were suspended from the University for unsatisfactory academic standing are in defiance of University regulations. Grades received by such students will not be credited to University baccalaureate programs whether or not they are reinstated as probationary students or achieve satisfactory academic standing after reinstatement.

Academic Dismissal

Students who fail to achieve satisfactory academic standing and are not granted extentions of their probations by the appropriate academic standards committees and students who are granted such extentions and fail to achieve satisfactory academic standing are dismissed from the University and are subsequently barred from attending both day and evening courses.

The University recognizes that dismissal from the institution for reasons of academic failure need not be permanent. Under the following circumstances readmission is ***possible***.

> Freshman and sophomore students who have been academically dismissed may qualify for readmission to the university as follows: 1) under the provisions of the Massachusetts Transfer Compact after completion of an associate degree at a Massachusetts community college; and 2) after a lapse of two years during which time they must have demonstrated their academic capacity and seriousness of purpose by obtaining an associate degree at a regionally accredited institution of higher education.
>
> Students of junior or senior standing at the time of dismissal may reapply for readmission to the university after an absence of at least two years if they have developed a record of successful work or professional experience during this period which demonstrates their seriousness of purpose. Additionally, the grade-point average at the time of dismissal must be sufficiently high to afford a reasonable chance of successful completion of their probationary periods or their degree requirements. Normally, readmission under this policy requires a commitment to full-time probationary studies. However, students who have less than 12 credits to complete for their degrees and who can comply with qualitative graduation standards by less than full-time studies may be readmitted for a probationary semester on less than a full-time basis.

The procedure for readmission of academically dismissed students begins with the filing of an application with the Admissions Office. The final decision to readmit an academically dismissed student rests with the Academic Committee of the College in which the student was enrolled at the time of dismissal from the University or (in the case of students with less than forty-five credits or three full-time semesters who may be permitted to make an intercollegiate transfer) with the Academic Standards Committee of the new college.

REGISTRATION AND COURSE ENROLLMENT POLICIES

All students are required to register for courses during periods which are officially designated for registration and preregistration unless they have been authorized to make other arrangements by the dean of the college in which they are matriculated. Non-matriculated students are permitted to enroll for course loads only as specified by their conditions of admission. Except for part-time students in the Second Chance program, all matriculated students (including probationary students) must register for courses which comply with prescribed courses of study and must comply with the policies (below) concerning semester course loads and reduced load status.

Calendar Deadlines for Changes of Course Enrollment Status

The last day for students to add a course, to change sections within a course, and to change enrollment status from audit to credit or from credit to audit and from pass-no credit to letter grade or from letter grade to pass-no credit is the 10th class day of the semester. The last day for dropping a course without penalty (with a course notation of "W") is the 40th class day of the semester. *Students must file all change of status forms in the office of the University Registrar by the published calendar deadlines.*

Semester Registration

Students are required to register *in person* during the designated preregistration and registration periods. Students have complied with the preregistration requirement when they have had a schedule of lecture, recitation, and laboratory work approved by their advisors and have filled in and processed the forms provided by the registrar's office. They have satisfied the registration requirement when they have paid the required tuition and fees and have complied with the course drop and add process. Endorsements of instructors and advisors are required for each change of enrollment card which is filed. Students who preregister for courses for which they subsequently fail to satisfy prerequisites must initiate changes of registration during the drop-add period. *Students are not enrolled in classes for which they are not properly registered.*

The office of the registrar mails copies of individual semester schedules to students at the mailing address on file in the registrar's office. Students are advised that such mailing constitutes official notification from the University concerning each individual's record of course registrations. Students who believe that errors have been made in their registrations should consult with the office of the registrar prior to the deadline for adding courses. *Students who do not check their mail and accordingly fail to correct scheduling errors by established deadlines may not expect to have University regulations waived for their benefit.*

Course Additions

Students who wish to add a course during the first 10 days of classes may do so by filing a properly authorized change of registration form with the office of the registrar. Any course which is added during the first 10 days of classes is subject to a course change fee, which will be charged unless a waiver is obtained from the dean of the college in which the student is enrolled.

Section Changes

Students who find it necessary to change a section within the same course because of time conflicts must file a change of registration form with the registrar's office within the first 10 days of classes. A change of course fee will be charged unless a waiver is obtained from the dean of the college in which the student is enrolled.

Dropped Courses

A student who wishes to drop a course may do so by filing a properly authorized change of registration form with the registrar's office. Courses dropped during the first 10 days of classes will not show on the permanent record. Courses dropped from the 11th to the 40th day of class will be assigned a grade of "W" and will appear on the permanent record.

Courses that are dropped are subject to a course change fee unless a waiver is obtained from the dean of the college in which the student is enrolled. There are only two cases for which a drop is not necessary:

1. If the course is cancelled by the University, or
2. If courses (or sections) carry no credit and will not appear on the permanent record card.

Courses Cancelled by the University

Students are not required to file drop forms with the office of the registrar for courses or sections which are cancelled subsequent to preregistration by the University. If students wish to replace a cancelled course with another, they must obtain signatures as specified by official forms before these are filed with the office of the registrar and, in the event that a fee waiver is applicable, also should secure signatures of the dean of the college in which they are enrolled.

1. To substitute a different course for a cancelled course, the student must file a change of registration form "adding" the replacement course. (A drop form must not be filed for a cancelled section!).
2. To substitute a different section for a cancelled section, the student must file a "section change" form.

Waiver of Fees

A waiver of fee for a course change is granted only when the change is necessitated by class cancellation. A waiver of fee is NOT granted when the change is initiated by the student for any reason, including unavailability of courses at the time of registration. For good and sufficient reason, the college dean may grant a waiver.

Minimum and Maximum Semester Course Loads

The typical course load expectation for full-time students is 15 credits. Professional curricula may specify credits in excess of this number, in which case such specifications are regarded as regular course loads. Students may enroll for course loads in excess of 15 credits but are advised that course loads in excess of the number of credits specified by recommended courses of study may not be in their academic interests when their grade-point averages are less than 3.00. Unless specified as part of an established course of study, course loads in excess of 15 credits are recommended for enrichment purposes only and should be taken as pass courses. In any event, a student is prohibited from registering for course loads in excess of 18 credits unless such loads are required by established University curricula or unless special permission has been granted by the dean of the college in which the student has established matriculation.

Students who are enrolled in curricula which do not require a semester course load in excess of 18 credits and who wish to obtain permission to carry such an overload must file an academic petition with the dean of the college in which they have established matriculation. Students who register for course loads in excess of 18 credits (including continuing education courses) without the prior authorization of the dean of the college in which they have established matriculation will not receive credit for more than 18 credits per semester and the college dean shall determine which course(s) shall receive the administrative symbol(s) of "Y". Permission to carry course loads in excess of stated maxima will be denied when resources of a college or program render it necessary to establish limitations on course enrollments. Matriculating students are classified as full-time when they carry a course credit load in University day programs which is specified by their curricula. Full-time students are required to register for a minimum of 12 credits of day courses each semester, and unless subsequently granted reduced load status, to remain registered for 12 credits of day courses at all times.

Reduced Load Status

Upon the written recommendation of a college dean, a full-time student may petition for exemption from the minimum course load requirement for reasons involving health or critical personal and academic problems. Such petition may be filed up to the 40th class day of the semester but cannot be made more than twice during a student's undergraduate career. Permission to carry a reduced load does not waive the requirement for completing degree requirements within 10 full-time semesters unless subsequent permission to extend the undergraduate period of study is granted by the dean of the college in which the student is matriculated.

Students who have been granted reduced load status are subject to all fees and academic regulations which are in effect for full-time students. Reduced load students are advised that they are not eligible for tuition refunds, that their financial aid eligibility may be jeopardized, that they may be ineligible to participate in varsity athletics, and that they must maintain satisfactory academic standing at the end of the semester during which a reduced load is authorized.

Special Matriculation Status

Individuals who have qualified for part-time matriculated studies in the Second Chance Program and candidates for baccalaureate degrees in day colleges having less than 12 credits to complete who have been granted permission to carry part-time programs are classified as special matriculating students. Special matriculating students pay limited fees and qualify for part-time tuition rates. Students who have less than 12 degree credits to complete may not petition for special matriculation status if they have previously carried reduced course loads for two semesters, and they may not be granted such status for more than two semesters.

Registration for University Continuing Education and Summer School Courses

Subject to University residency requirements and college regulations*, the following categories of day students may be permitted to register for continuing education and summer school courses at the University of Lowell and to have such courses credited to baccalaureate day programs:

1) individuals who have been admitted to day colleges for full-time baccalaureate study,

2) individuals in satisfactory academic standing who are currently matriculating in day colleges of the University**, and

3) previously matriculated students in day colleges who withdrew from the University while in satisfactory academic standing, who have been absent from the University for periods of not more than two semesters, and who have been readmitted to programs in which they were previously enrolled.

* Special authorization is required by the College of Management Science for continuing education courses in areas of accounting, economics, and management.

** Students on academic warning are permitted to register for continuing education and summer school courses.

Individuals are warned that departments reserve the right to deny baccalaureate credit for University of Lowell continuing education and summer school courses which have been taken in violation of University residency requirements, curriculum requirements of their baccalaureate day programs, and/or special college regulations. Accordingly, individuals are advised to consult appropriate sections of this publication prior to enrolling in continuing education and summer school courses of the University in order to avoid subsequent denial of course credit during the period when programs of study are reviewed for the purpose of determining student satisfaction of degree requirements. Students who have been suspended or dismissed from day programs of the University are prohibited from enrolling in any program of the University. Students who combine University day courses with continuing education courses during the regular academic year are subject to all restrictions concerning semester course loads. (Cf. "Registration and Course Enrollment Policies".)

REPEATED COURSEWORK

Course repetition is permitted only in accordance with the policies cited below, the provisions of which are applicable only to courses taken at the University of Lowell and consequently do not apply to off-campus courses. A course substitution is not permitted under the provisions of this regulation unless a course has been dropped as a University offering and an alternate course has been authorized as a suitable substitution by the chairperson of the department which offered the course. Once a student has reached the credit limitations which are cited below, no further courses may be replaced for the purpose of grade substitution, nor may a student who has used the maximum number of course repetitions for the purpose of grade substitution petition to revoke one or more of these substitutions in order to permit course repetition and grade substitution in an additional course or courses.

Grade Substitution Rule

Students who have entered the University as freshmen or transferred to the University with less than 60 semester credits are permitted a maximum of 10 semester credits of course repetitions for the purpose of substituting grades for previously completed courses in the computation of their cumulative grade-point averages. (Transfer students who have entered the University with 60 or more credits are permitted a maximum of seven semester credits of course repetitions for this purpose.) The number of actual course repetitions which are permitted for any student depends upon the number of credits which are allocated to those courses which he or she wishes to repeat. For instance, a student who has entered the University as a freshman may repeat a three credit course three times or a four credit course two times. However, such a student may not repeat both a three credit and a four credit course two times since such repetitions exceed the maximum number of semester credits which are permitted under the grade substitution rule.

Administrative Requirements

When students register for courses which they wish to repeat, they must notify the office of the registrar at the time of registration for the fall or spring semester, or at the time of registration for University summer sessions. Students who wish to repeat courses which they have previously passed must file an approved academic petition at this time. Such students are advised that permission to repeat courses may be denied when resources of a college render it necessary to establish limitations upon course enrollments.

Deadlines

Students in satisfactory academic standing and students on academic warning must repeat courses within two semesters of their previous course completions or during the semester in which the courses are next offered—whichever period is later. Probationary students may repeat those courses which they completed during the two semesters immediately preceding their suspensions. These courses must be repeated within two semesters of the previous course completion (not counting the period of academic suspension from the University) or during the semester in which they are next offered—whichever period is later.

Repetition of Passed Courses

Except for courses of a professional nature which regulations of a college may designate as being non-repeatable, students may repeat a previously passed course within the provisions of the grade substitution rule cited above. When a previously passed course has been repeated within the provisions of this regulation, the cumulative grade-point average is appropriately corrected for the semester in which the course is repeated. *If the grade for the repeated course is lower than the original grade in the course, both grades will be counted in the student's cumulative average. Credit is never granted twice for a course which has been taken and passed and subsequently taken again and passed for the second time.*

Repetition of Failed Courses

Except for courses of a professional nature which regulations of a college may designate as non-repeatable, students may substitute passing grades for repeated failed courses in the computation of cumulative grade-point averages. Except for non-repeatable courses, *students must repeat all required courses which they have failed.* Courses in which "F" grades have been received must be repeated and passed before students may take courses for which those failed are prerequisites. A course which is failed but is not required for a student's program need not be repeated, but other course work must be taken when a student's total degree program will fall short of the specified credit hours for degree requirements. Unless a failed course is repeated within the deadlines for grade substitution cited above, both the original failing grade and the repeated course grade are counted in computing grade-point averages. Although the provisions of the grade substitution rule and the requirements for maintaining satisfactory academic standing may indirectly limit the number of failed courses which a student may repeat, no formal limitation is placed upon the number of failed courses which may be repeated. The number of *course repetitions with grade substitutions*, however, is limited by regulations governing grade substitution; refer to "Grade Substitution Rule", above.

Repetition of Transferred Courses

When competence is demonstrably inadequate, a student who has been granted transfer credit (and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite) may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred.

Permission to repeat a transferred course is granted by filing an academic petition form with the dean of the college. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

WITHDRAWAL FROM THE UNIVERSITY

All students who desire to withdraw from the University are required 1) to discharge all financial obligations to the University, 2) to return all University property, 3) to have a conference with the Dean of Students, and 4) to file a written notification of withdrawal with the office of the registrar. Since the date of official withdrawal, as recorded by the office of the registrar, is one basis of any claim for tuition refund, and may be of importance in determining subsequent legal or student insurance claims, students should process withdrawal papers in person prior to leaving the University. Students who absent themselves from the University without officially withdrawing will remain on class rosters until they officially withdraw from the University or until the end of the semester. Students who remain on class rosters after the 40th class day will be assigned final course grades. The date on which a withdrawal request is filed with the office of the registrar is the date on which withdrawal is academically effective and constitutes the basis for final course notations.

The names of students who have withdrawn from the University for any reason are removed from all rolls. Students who have withdrawn must be reinstated. This is accomplished only through the office of admissions.

Students who are recipients of benefits from the Veterans Administration may not process withdrawals from the University which violate their declarations of classroom attendance. Recipients of veterans benefits are advised that they must receive course grades when their requests to withdraw from the University have been filed after deadlines of the Veterans Administration for processing changes of declared benefit status or when their dates of withdrawal will conflict with declarations of classroom attendance.

University Withdrawal Through the 40th Class Day

Students who register for courses and who withdraw from the University prior to the first day of classes of a semester are withdrawn without record. Students who register for courses and who withdraw from the University from the 1st to the 40th class day of a semester are withdrawn with course notations of "W".

University Withdrawal After the 40th Class Day

A student who withdraws from the University during the period from the 41st class day to the end of the semester must be graded by all course instructors unless the student is authorized to withdraw for reasons of extended illness or critical personal emergency. A student who wishes to withdraw temporarily or permanently from the University after the 40th class day of a semester for such reasons must file an academic petition, together with appropriate documentation, with the dean of the college in which he or she is enrolled. Following a review of the academic petition and verification of attached documentation, the dean of the college may permit the student to withdraw from all courses. The completed petition must be filed with the office of the registrar prior to the student's departure from the University.

University Withdrawal After the End of the Semester

A student who has *unofficially withdrawn* (i.e., has ceased attending classes) from the University for reasons of extended illness or critical personal emergency and (for reasons acceptable to the dean of his or her college) has been unable to officially withdraw from the University before the end of the semester may petition to withdraw from all courses with symbols of "X". Such a student must file an academic petition, together with supporting documentation, no later than one calendar month from the beginning of the following semester. This petition must be filed with the registrar, who will forward all materials to the appropriate college dean for a decision.

Following a review of the academic petition and verification of attached documentation, the dean shall forward his or her decision to the registrar, who shall notify the student of the dean's decision. A student who has been the recipient of benefits of the Veterans Administration may petition to withdraw from the University after the end of the semester only when he or she has been provided with written authorization from the Veterans Administration.

OFF-CAMPUS STUDY

Matriculating students in satisfactory academic standing may be permitted to apply off-campus courses to their degree programs when they comply with established procedures. Off-campus courses may be taken in accredited institutions only, and ordinarily should be taken at baccalaureate colleges or universities. Permission to pursue off-campus courses in accredited associate degree institutions may be granted only for courses which are to be presented for lower-division requirements of University of Lowell curricula. All off-campus courses must be taken under the regular grading system and may not be taken on a pass-no credit (pass/fail) basis.

Transfer Recognition

Courses completed off campus may be recognized as transferred courses without quality-point designations if they have been completed with grades of "C" (2.00 on a 4.00 scale) or better. Students wishing to receive recognition of such completed courses must petition the chairperson of their major department and the chairperson of the department offering those courses for which the completed off-campus courses are offered as substitutes and must file an approved academic petition with the office of the registrar prior to the end of the semester which follows their completion of the off-campus courses.

University Restrictions Concerning Off-Campus Study

Students are not permitted to pursue off-campus courses until an initial evaluation of their academic progress at the University has been made. *Students who have transferred to the University with 60 or more semester credits, who have transferred with an associate degree,* or who have been admitted from another institution with a baccalaureate degree to pursue a second bachelor's degree, *are not permitted to pursue off-campus studies.* Students who combine University courses with off-campus courses during the regular academic year are subject to University restrictions on semester course loads.

Full-Time Off-Campus Study (Year Abroad and Visiting Student Programs)

Off-campus courses may be authorized on a full-time basis for those students who have completed (or who will complete prior to graduation) three years of full-time study at Lowell (earning not less than 90 semester credits) and who wish to pursue a year or a semester abroad or who wish to complete a year as visiting students at another baccalaureate institution while completing a Lowell degree. Students planning to undertake full-time off-campus study should consult with appropriate department chairpersons well in advance of such study and must file an academic petition (signed by appropriate department chairpersons) with the dean of the college in which they are enrolled. Within one month of the date when the petition was filed with the college dean, he or she will forward written notification to both the student and the registrar that the request has been approved or disapproved, indicating whether special restrictions or reservations shall apply for an approved off-campus program and whether or not course grades for such a program will be granted qualitative recognition.

Since some colleges of the University do not permit full-time off-campus study, students should ascertain the policy of their college before pursuing arrangements with other institutions. Students who wish to pursue full-time off-campus studies are advised that they must satisfy academic and residency requirements concerning courses in the major field. (Cf. "General Degree Requirements: Residency Requirements".)

ACADEMIC ADVISORY SYSTEM

Academic advising is performed by full-time faculty members. Students who have been accepted by departments for academic or professional majors receive their academic advising from a member of their major department or, in the case of students pursuing interdisciplinary majors, from members of an appropriate interdisciplinary committee. Students who have not made declarations of their major fields are assigned faculty advisors from within the college in which they are enrolled. Entering students are advised during the period of initial registration by a cadre of faculty advisors and are subsequently assigned advisors on the basis of their declarations of major subject. If an advisor has not been assigned by the beginning of the advisory period of the student's second registration, the student should immediately reveal this fact to the dean of the college in which he or she is enrolled.

The faculty advisor assists the student in developing a program of courses prior to semester registration and in formulating a program of studies leading to a degree and generally provides whatever guidance and assistance a student may require in making appropriate academic decisions throughout his or her period of baccalaureate studies. *However, each student is personally responsible for complying with all rules and regulations of the University and is solely responsible for completing all degree requirements.*

The advisor maintains records showing the program of study for each of his or her assigned students, including subjects taken, grades received, and changes of contemplated programs. For the purpose of providing appropriate academic advising, each faculty member is available for consultation throughout the semester. Faculty members are contractually required to maintain three office hours per week on at least two different days during periods in which classes are scheduled and to maintain a minimum of five office hours per week on three days during periods of student advisement for course registration. Schedules of office hours are published by departments for their members and the schedule of faculty office hours for each faculty member is posted in such a manner as may be observed easily by students.

COURSE REQUIREMENTS

Within the policies listed below, faculty members are permitted to establish their examination and course requirements.

Course Examination Policies

Final examinations are required for all undergraduate courses of the University unless exemptions have been granted by the department chairperson and the dean of the college. Exemption requests must be made by the end of the first month of the semester. Final examinations may not be given at a place or time other than those which have been specified by the registrar. There shall be no final examinations other than those administered during the final examination period. No hour examination shall be administered during the last five academic days of the semester unless exemption has been allowed by the college dean. Final take-home examinations may be submitted to instructors during the final examination period only. Take home examinations may be submitted only on the day and at the time which the registrar has scheduled the final examination for the course in question.

Instructor Course Requirements

By the end of the first full week of classes, instructors must distribute a written statement of requirements for each course and section to all students and to the department chairperson. This statement must include a specification of the number and types of course evaluations to be employed throughout the semester (including approximate date and nature of the first evaluation), special requirements for completing assignments and taking examinations, and a definition of course attendance policy. One copy of this statement shall be deposited with the instructor's department chairperson.

Normally, a minimum of three evaluations of student progress (written or oral examinations, written reports, recitations, laboratory techniques and reports, jury or performance evaluations) should be made in each course, at least one evaluation being required during each half semester. Upon the request of a student, an instructor is required to provide a statement of the student's course progress. Prior to the last date for withdrawing from courses, students who are in danger of receiving "D" or "F" grades either shall be so notified by the instructor or shall be in possession of such course evaluations as will permit such students to reasonably infer their course progress and academic jeopardy.

Prior to the mid-semester point of the Fall semester, instructors shall provide a progress report for all freshmen students. This report will be made on appropriate University forms and filed with the office of the college dean. Instructors will receive lists of freshmen students who are enrolled in their courses from the office of the registrar.

ATTENDANCE POLICIES

Although the University does not require class attendance as a matter of institutional policy, course instructors have the option of establishing required attendance in their courses and of specifying penalties for student violations of such attendance requirements. Colleges also have this option and sometimes have adopted attendance policies for introductory courses and specialized learning situations.

Instructor Attendance Policies

At the beginning of each course, the instructor will inform students of any specific attendance regulations which apply.

Attendance Requirements of the Veterans Administration

In compliance with the requirements of the Veterans Administration, all recipients of Veterans benefits, including eligible children of veterans, must certify their attendance at the University under penalty of perjury by the following procedures:

On the first Monday of each month, or on the following day if Monday is a holiday, each recipient of VA benefits is required to register his or her attendance at the office of the dean of his or her college. This procedure is also repeated on the third Monday, or on the following day if Monday is a holiday. All changes in status of the VA recipient also must be reported. Failure to register attendance will be reported immediately by the college dean to the registrar, who will attempt to contact the student personally. If no satisfactory response is elicited for failure to register within one week of the reporting date, or if the registrar is unable to reach the student at his or her official residence, the registrar will inform the Veterans Administration that the University is unable to verify this student's attendance.

COURSE NOTATION SYSTEM (Bulletin Nomenclature Policy)

Each course offering is designated by a two-digit prefix and a three-digit course number. The two digit college prefix identifies a college department and/or special area. The three-digit course number identifies the course level.

Course Prefixes

Each college department and/or special subject area has been assigned an identifying two digit number (for example, 92-131) within the numerical ranges specified as follows:

Aerospace Studies	29	Liberal Arts	40-59
Education	01-09	Management Science	60-69
Engineering	10-28	Music	70-79
Health Professions	30-39	Pure & Applied Science	80-99

Course Numbers

A course number consists of three digits which follow the course/department prefix (for example, 92-131). Courses numbered 001-099 are pre-freshman and special undergraduate courses and do not carry baccalaureate degree credit. Those numbers 100-299 are lower division undergraduate courses and those numbered 300-499 are upper division undergraduate courses. The 400 level courses are generally limited to juniors and seniors majoring in a field but are open, with permission, to other undergraduates and to graduate students. Directed studies courses and practicum experience courses are generally limited by departmental policy to students majoring in the area in which such courses are offered. Courses numbered 500-599 are graduate courses which are open to upper division undergraduates with the consent of instructors and chairpersons. Courses numbered 600-699 are graduate courses which are open only to graduate students. Courses numbered 700-799 designate graduate research projects and graduate theses.

Course Restrictions

Special course prerequisites, corequisites, and enrollment restrictions are indicated at the end of the course description. A course which is listed as a prerequisite must have been completed and passed prior to taking the course for which the prerequisite is specified. Subject to college or department policy to the contrary, an exception to this limitation may be granted by the designated instructor only. A course which is listed as a corequisite must be taken during the same semester as the course for which the corequisite is specified. Courses which carry such notations as "open for majors only" and "sophomore status required" are restricted to the specified students. Courses which carry the notation "permission of instructor" require instructor approval prior to filing enrollment cards with the office of the registrar. Courses at the 100-300 levels which do not carry prerequisite, corequisite, and enrollment restrictions are open for election by all students unless general restrictions have been listed under the department or course area heading, or unless policy of the college or department in which the student is matriculated prohibits such registration.

AEROSPACE STUDIES (Air Force ROTC)

University Policies Concerning Aerospace Courses

Both the General Military Courses (AS 100 and AS 200) and Professional Officer Courses (AS 300 and AS 400) in Aerospace Studies may be used as undesignated or unrestricted elective courses in a student's baccalaureate program. Grades for all AFROTC courses are applicable to the determination of grade-point averages. Students should consult the regulations of the college in which they are matriculating concerning the number of AFROTC courses which may be included as part of their programs of study. In the event that such elective courses are insufficient to accomodate all the AFROTC courses, students wishing to pursue the AFROTC program will be required to fulfill program requirements on an overload basis. Consequently, AFROTC credit toward graduation requirements will vary from six (minimum to meet AFROTC/University of Lowell contract requirements) to sixteen credits dependent on the student's particular college and degree program. Some colleges allow AFROTC courses to be substituted for technical or general electives.

The Air Force ROTC Program

The program is designed to qualify for commissions those men and women who desire to serve in the United States Air Force and to provide an eduction which will develop skills and attitudes of vital importance to professional Air Force officers. The Air Force ROTC program is divided into two phases: 1) the general military course (GMC), and 2) the professional officer course (POC).

Students may elect to enroll in the four-year AFROTC program or the two-year AFROTC program. Students electing the four-year program will take the general military course during their freshman and sophomore years. The GMC consists of one hour of class and one hour of leadership laboratory per week. Students in the four-year program attend four weeks of field training during the summer between their sophomore and junior years. As members of the program, they are eligible to compete for AFROTC scholarships. For acceptance into the professional officer course, students enrolled in the four-year program must pass a physical examination, an officer qualification test, and possess an acceptable academic record. The POC consists of three hours of class and one hour of leadership laboratory per week.

To qualify for enrollment in the two-year program, students must have two academic years remaining at either the graduate or undergraduate level or combination of these levels. They must also meet certain physical standards, pass an officer qualification test, and possess an acceptable academic record. They must also successfully complete a six-week field training course before they can be accepted into the POC.

Uniforms, equipment, and textbooks which are required for AFROTC will be supplied. Students in the POC receive a monthly subsistence allowance of $100.00. Competitive scholarships are available to cadets in the program. Students who successfully complete the POC are commissioned as second lieutenants in the United States Air Force Reserve and serve on active duty in the Air Force in a specialty which is closely related to their academic training and is consistent with needs of the Air Force.

All GMC scholarship cadets must satisfactorily complete a course in English composition within two years of the scholarship activation. In addition, all scholarship cadets must satisfactorily complete two semesters of a major Indo-European or Asian language prior to commissioning. All cadets, both scholarship and non-scholarship, must complete a course in mathematical reasoning prior to commissioning.

Field Training

AFROTC field training is offered during the summer months at selected Air Force bases throughout the United States. Students in the four-year program participate in four weeks of field training, usually between their sophomore and junior years. Students applying for entry into the two-year program must successfully complete six weeks of field training prior to enrollment in the professional officer course.

The major areas of study in the four-week field training program include junior officer training, aircraft and aircrew orientation, career orientation, survival training, Air Force base functions and environment, and physical training.

The major areas of study included in the six-week field training program are essentially the same as those conducted at four-week field training and in the general military course including leadership laboratory.

AFROTC students who successfully complete either the four or six week field training program will have their University physical activity requirement waived.

Leadership Laboratory

Leadership laboratory is taken an average of one hour per week throughout the student's period of enrollment in AFROTC: 60 hours in the general military course and 60 hours in the professional officer course. Two-year program students participate in the latter only. Instruction is conducted within the framework of an organized cadet corps with a progression of experiences designed to develop each student's leadership potential. Leadership laboratory involves a study of Air Force customs and courtesies, drill and ceremonies, career opportunities in the Air Force, and the life and work of an Air Force junior officer. Students develop their leadership potential in a practical, supervised laboratory, which typically includes field trips to Air Force installations throughout the United States.

DEPARTMENT OF AEROSPACE STUDIES (Course Prefix: 29)

Lt. Col. Russell J. Urban, Chairperson
Professor: Russell J. Urban
Assistant Professors: Ronald A. Basque, Robert G. Hunsaker, Linda S. Michael

The Department of Aerospace Studies is a unit of the office of Academic Affairs and conducts the Air Force ROTC program. All ROTC courses may be taken by any university student without actually joining the AFROTC program. Call (617) 459-9301 or stop by Southwick, Room 328, for additional information.

29-101 THE AIR FORCE TODAY—PART I **I(1,0)1**
This course deals with the Air Force in the comtemporary world through a study of the total force structure, strategic offensive and defensive forces, general purpose forces, and aerospace support forces. Capt. Hunsaker.

29-102 THE AIR FORCE TODAY—PART II **II(1,0)1**
Completion of the material described in 29-101. Capt. Hunsaker.

29-201 THE DEVELOPMENT OF AIR POWER—PART I **I(1,0)1**
The course is a study of air power from balloons and dirigibles through the jet age, a historical review of air power employment in military and non-military operations in support of national objectives, and a look at the evolution of air power concepts and doctrine. Lt. Col. Urban.

29-202 THE DEVELOPMENT OF AIR POWER—PART II **II(1,0)1**
Completion of the material described in 29-201. Lt. Col. Urban.

29-301 AIR FORCE MANAGEMENT AND LEADERSHIP—PART I **1(3,0)3**
An integrated management course emphasizing the individual as a manager in an Air Force milieu. The individual motivational and behavioral processes, leadership, communication, and group dynamics are covered to provide a foundation for the development of the junior officer's professional skills as an Air Force officer (officership). The basic managerial processes involving decision-making, utilization of analytic aids in planning, organizing, and controlling in a changing environment are emphasized as necessary professional concepts. Organizational and personal values, management of forces in change, organizational power, politics, and managerial strategy and tactics are discussed within the context of the military organization. Actual Air Force cases are used to enhance the learning and communication processes. Capt. Michael.

29-302 AIR FORCE MANAGEMENT AND LEADERSHIP—PART II **II(3,0)3**
Continuation of the material described in 29-301. Capt. Michael.

29-401 NATIONAL SECURITY FORCES IN CONTEMPORARY AMERICAN SOCIETY—PART I **I(3,0)3**
Aerospace Studies 401 and 402 is a full year course focused on the armed forces as an integral element of society, with an emphasis on American civil-military relations and the context in which U.S. defense policy is formulated and implemented. Special themes include: social attitudes toward the military; the role of the professional military leader-manager in a democratic society; the values and socialization processes associated with the armed services; the requisites for maintaining adequate national security forces; political, economic, and social constraints on the national defense structure; the impact of technological and international developments on strategic preparedness; the national security policy; and military justice. In each semester, students will be expected to prepare individual and group presentations for the class, write reports, and otherwise participate in group discussions, seminars, and conferences. Capt. Basque.

29-402 NATIONAL SECURITY FORCES IN CONTEMPORARY AMERICAN SOCIETY—PART II **II(3,0)3**
Continuation of the material described in 29-401. Capt. Basque.

FACULTY OF AEROSPACE STUDIES

Russell J. Urban, Lieutenant Colonel, USAF, Professor of Aerospace Studies; B.A., Central Washington State University; M.A., State University of New York
Ronald A. Basque, Captain, USAF, Assistant Professor of Aerospace Studies; B.S., University of Lowell; M.A., Webster College
Robert G. Hunsaker, Captain, USAF, Assistant Professor of Aerospace Studies; B.S., San Jose State University; M.B.A., University of North Dakota
Linda S. Michael, Captain, USAF, Assistant Professor of Aerospace Studies; B.S., University of Nevada, Las Vegas; M.A., Webster College

COLLEGE OF LIBERAL ARTS

Peter F. Blewett, Acting Dean
Richard L. Derry, Assistant Dean

At its best, a liberal education involves the active pursuit of truth as well as a knowledge of ourselves as human beings and of the societies we have constructed. It recognizes and utilizes aesthetic quality and curiosity as inherent motives for human learning. It encourages students to achieve the confidence and to acquire the knowledge and skills necessary to face problems and to deal with them realistically, giving attention to their potential consequences for others as well as for themselves. A liberal education should enable students to comprehend, support, and/or criticize society by fostering freedom of thought, social interaction, and a willingness to make decisions based upon an objective evaluation of the situations as well as upon one's own considered personal values. It should result in orderly processes of thought, respect for relevant evidence, and a sense of obligation to test one's own generalizations. In short, it should prepare one to deal with a complex and rapidly changing environment from the special perspective of one's own chosen field.

OBJECTIVES OF THE COLLEGE OF LIBERAL ARTS

The broad objective of a liberal education to the modern world is to develop through the study of the social sciences and the humanities men and women who are open to change and to the challenges of an uncertain future. The liberal arts program in the University of Lowell recognizes the interdependence of human communities and the balance existing between these and the natural world, and it aims at building an understanding of our cultural and scientific heritage while developing the ability to use the concepts and skills of the academic disciplines in a critical and integrated way. Aside from the special vocational implications of the various disciplines, a liberal arts education can assist the individual to function freely, realistically, and creatively, to respond to challenges with aesthetic sensitivity and intellectual curiosity, and to develop a commitment to life-long learning and personal fulfillment. The College of Liberal Arts recognizes that the attainment of those skills and habits of mind which are vital to the fulfillment of both vocational and developmental goals are in great part the consequence of personal motivation. For this reason, students are allowed considerable latitude in developing their programs of study in regular consultation with their faculty advisors.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Liberal Arts is organized into nine departments and is administered by a dean and assistant dean. The departments and several interdisciplinary committees are responsible for developing course offerings and programs of studies. Although the faculty of the college has overall responsibility for all academic policies of the college, the academic standards committee is responsible for enforcing the standards set by the college and the University and also serves as a review body for suspended students seeking readmission with probationary status.

Curriculum Committee

Dr. Liana Cheney, Art
Dr. Joseph Lipchitz, Criminal Justice
Dr. William Hersey, English

Dr. Mario Aste, Languages
Dr. Eugene Mellican, Philosophy
Dr. Frederick Lewis, Political Science
Dr. Richard Siegel, Psychology
Dr. Mitra Das, Sociology

Academic Standards Committee

Dr. Mitra Das, Sociology
Dr. Hai B. Pho, Political Science
Prof. Anthony Turrisi, English
Prof. Joseph Waterman, Psychology
Dean Richard Derry

BACCALAUREATE DEGREE PROGRAMS

The College of Liberal Arts offers undergraduate programs leading to the degree of Bachelor of Arts, Bachelor of Science, and Bachelor of Fine Arts. All degree programs of the College provide a broad, comprehensive education with many options for developing major and minor programs and ordinarily provide sufficient preparation for graduate progams which require students to possess a general liberal arts background. Students who matriculate for the degree of Bachelor of Science in the College of Liberal Arts pursue the major program in the Administration of Criminal Justice. The Bachelor of Fine Arts degree is offered by the art department.

Dual Degree Program: Bachelor of Arts/ Bachelor of Science in Engineering

The College of Liberal Arts and the College of Engineering offer five (5) year dual degree programs which permit the student to earn a Bachelor of Arts degree in one of the following areas of liberal arts: American Studies, art, English, languages, history, political science, philosophy, psychology, or sociology, while simultaneously earning a Bachelor of Science in Engineering degree in a designated engineering field: chemical, civil, electrical, mechanical, nuclear, or plastics engineering.

Students entering the dual degree program must meet the entrance requirements of both colleges. Curricula for dual degree programs are approved by the faculties of the participating colleges and must be completed as prescribed. It is imperative that students entering the liberal arts/engineering dual degree program obtain a copy of the curriculum which enumerates the specific semester course requirements. The curriculum is available from the Dean of the College of Liberal Arts or from the Dean of the College of Engineering.

Both the Bachelor of Science in Engineering and the Bachelor of Arts degrees are conferred at the end of the fifth year. The conferral of the Bachelor of Science in Engineering degree is contingent upon the completion of all the requirements for the degree of Bachelor of Arts.

GENERAL COLLEGE REQUIREMENTS

In order to qualify for a baccalaureate degree offered by the College of Liberal Arts, each undergraduate must comply with the University core requirements, must conform to the rules of the College of Liberal Arts which govern degrees and major studies for such degrees, *and must earn a 2.20 average in his or her major area(s) of concentration by the end of the senior year.* Students who have failed to achieve a 2.00 average in their major concentration(s) by the end of the junior year (typically 27 hours in the major of 89 hours undertaken by the end of the junior year) have not made satisfactory progress toward their degrees, and upon the recommendation of appropriate departmental committees and the concurrence of the academic standards committee of the college, such students may be placed on probationary status within the college or dismissed from the University for inadequate scholarship.

Minimum Degree Requirements in the College of Liberal Arts

All degree programs include the following:

Core requirements	**Credits**
English Composition	6
Areas I, II	18
Area III	9-11
Values requirement	3
Physical education	2
	38-40*
Liberal Arts major	30-45**
Collateral and elective courses (including minor, if any)	37-54
Minimum degree requirements	120

Baccalaureate Options

Options for second majors and minor studies are permitted as specified below:

1. Students may elect a second major which is offered by the College of Liberal Arts or, upon approval of the Dean of the College of Liberal Arts, they may elect a second major which is offered by other colleges of the University. But note that an English major may not declare a second major in American Studies; nor may an American Studies major choose a second major in English, history, political science or sociology. Students who elect academic majors in more than one college are candidates for one degree only, and they are considered to be degree candidates in the college of their initial major unless they indicate to the contrary at the time they make a declaration of second major by filing for intercollegiate transfer. Accordingly, a student who pursues academic majors in the

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* The College of Liberal Arts requires that a student whose major(s) is (are) offered within the college, or whose primary major (in the case of students pursuing majors in more than one college) is offered within the college, must complete the area distribution requirement as specified and no exemption, in whole or in part, is permitted to a student whose academic major falls within a discipline which is listed under Area I or II.

** The Bachelor of Fine Arts program requires a total of 87-90 credits in studio art and art history courses.

College of Liberal Arts and another college is subject to all degree requirements as specified by the college of his or her initial major and is subject only to major course requirements (including any collateral and prerequisite courses for the major) as specified by the department of his or her second major. For a full discussion of University requirements concerning second majors, students should consult the relevant section of this publication which appears under the heading "Academic Policies".

2. In accordance with the requirements of established minor programs, students who matriculate for degrees in the College of Liberal Arts may undertake a minor from those areas cited below which are distinct from the disciplines comprising their majors. The curriculum committee of the College of Liberal Arts will from time to time review and, when appropriate, approve new minors in addition to those listed below. Students should consult with their advisors concerning additions to the approved listing of minors. Specific options for minor programs will depend on the major field which a student has elected to pursue and the collateral course requirements which have been specified by their major departments. Students are advised that an aggregation of courses which total 18 or more credits does not constitute a minor area and they are referred to University policies which appear elsewhere in this publication under the heading "Academic Policies: Minor Area Requirements" for further discussion. Students who wish to elect a minor program in colleges other than the College of Liberal Arts should refer to the appropriate section of this publication concerning prerequisites, restrictions, and prescribed sequences of courses.

American history
American literature
American studies
art history
biology
chemistry
classical civilization*
clinical science**
cognitive science
drama
economics
earth science
English
English literature
European history
French
German Studies
Greek
Italian Studies
music++
health**
history
Latin American studies*
legal studies*
mathematics (including computer programming option)***
philosophy
physics
political science
psychology
public affairs
social science
sociology
Spanish
studio art
technology, society and human values*
western cultural heritage*
women's studies*
writing

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* See listing of interdisciplinary minors at the end of the College of Liberal Arts section of this bulletin.

** Refer to interdisciplinary course/programs in the College of Health Professions section of this bulletin.

*** Courses for a minor area in mathematics (including the computer programming option) require approval in advance by the chairperson of the mathematics department.

++ Several options are available including 1)music history and literature, 2)music theory, history and literature, and 3)music history, history and literature plus performance. Refer to the listing of minors in the College of Music section of this bulletin. (Note that the minor in sound recording technology is NOT available as an option to students in the College of Liberal Arts).

3. With the approval of their faculty advisors, matriculating students in the College of Liberal Arts may develop programs of elective courses for the purpose of providing greater personal and professional relevance to their major fields. Such programs may be developed from among those disciplines which are listed above as areas in which elective courses may be authorized for matriculating students of the College of Liberal Arts.
4. Matriculating students in the College of Liberal Arts who do not choose to take a second major or a minor must present at least six semester credits in courses which are on the "300" level among those elective courses offered in fulfillment of collateral degree requirements.

Honors Program

The College of Liberal Arts offers a program leading to the award of an honors degree. Graduates will receive an honors diploma (which is distinct from any University or college honors awarded at commencement). Entry into the program is limited to upper class students (60 or more credits) who have demonstrated a high level of academic achievement and the motivation necessary to complete the requirements. Students who have transferred to the University, in addition to meeting the qualifications, must have completed not less than two semesters of full time study in the College of Liberal Arts.

To qualify, a student must have attained a minimum cumulative grade point average of 3.0 and must demonstrate foreign language competency at the intermediate level, or above. In addition, the student must successfully complete 41-401, Honors Seminar, and 40-402, Honors Tutorial, with grades of "B"or better. Students who are interested in the program-should apply during the first semester of their junior year to the program coordinator, Dr. Peter Blewett, History Department, Coburn 105.

Declaration of Major and Change of Major

Students who are matriculating for degrees in the College of Liberal Arts are required to designate degree majors in the college. The College of Liberal Arts does not, however, require students pursuing the Bachelor of Arts degree to declare their major fields until the semester in which they will complete 60 semester credit hours. The college will cancel the registration of any student who has completed 60 semester credit hours without declaring an academic major. Students should consult policies listed elsewhere in this publication under the heading "Academic Policies: Major Field Requirements" for a complete discussion of declaration of major, declaration of second major, and change of major with intercollegiate transfer.

Language Proficiency Requirement

Effective with the class of 1991 (entering the University in September, 1987) and for all subsequent classes the College of Liberal Arts will require intermediate language proficiency for all candidates for the Bachelor of Arts degree. Students transferring to the college after September, 1987 will be subject to the requirements in effect for the class in which they are accepted for transfer. Candidates for the Bachelor of Science in the Administration of Criminal Justice must demonstrate *either* intermediate proficiency in a modern foreign language *or* an equivalent proficiency in computer programming and statistics. (Refer to the degree requirements for the Criminal Justice degree in this section of the bulletin for a statement of the latter option.)

Students may satisfy the requirement of intermediate language proficiency through any one of the following options:

a. a score of "550" or above on a College Entrance Examination Board Achievement Test;

b. a score of "3" or above on a College Entrance Examination Board Advanced Placement Examination;

c. a satisfactory score in a proficiency test prepared and administered by the Language Department of the University of Lowell (preferably during the student's freshman year) and covering a reading knowledge of any one of the following languages: French, German, Greek, Italian, Latin, or Spanish;

d. passing two semester courses on the intermediate, second-year college level in a language previously studied in secondary school and offered by the University of Lowell; or

e. passing a minimum of 12 semester credits in beginning and intermediate courses in a single language, the study of which is initiated at the University of Lowell.

Satisfaction of the language proficiency requirement for the Bachelor of Arts in the College of Liberal Arts is further governed by the following regulations:

1. Students who satisfy the language proficiency requirement through any of the options listed above will be granted the appropriate credits toward the baccalaureate degree but credits thus awarded will not, in whole or in part, be applicable to the area requirements of the University core curriculum.

2. Students who elect to satisfy the language proficiency requirement through options (d) and (e) listed above are prohibited from registering on a pass-no credit basis for courses taken toward satisfaction of this requirement.

3. The College of Liberal Arts strongly recommends that a student who elects to take a Language Department proficiency examination do so during the freshman year. Students who transfer to the college after their freshman year who elect to take a language proficiency examination should do so during their first year in the College of Liberal Arts.

4. The College of Liberal Arts does not recognize and will not award credit for a subject examination in a foreign language offered by the College Level Examination Plan (CLEP). Students who are matriculating in the College of Liberal Arts and who seek to establish proficiency *via examination* should arrange with the Language Department to take a proficiency test during their first year of matriculation.

Restrictions on Enrollment in Other Colleges of the University

Students are not required to complete a minimum number of credits or courses in the College and are permitted to elect courses in other colleges of the University which are relevant to the academic orientation of their liberal arts programs. *However, courses of a distinctly professional orientation are not applicable to programs of the college and, irrespective of* *any permissive regulation of another college, they are not accepted for degree credit by the College of Liberal Arts.* Students who are able to satisfy prerequisite requirements may elect, without authorization, courses in:

- College of Pure and Applied Science—all courses.
- College of Management Science—courses in economics (prefix 64)
- College of Music—courses in music history and literature (prefix 74); ensembles (prefix 76), except that 76-106 Marching Band, may be used to satisfy the physical education requirement only.
- College of Health Professions—courses of a non-professional nature, except that physical activities courses may not be elected as part of the minimum degree requirements.
- Department of Aerospace Studies—all courses.

Courses which *may not* be elected and for which degree credit *will not* be allowed include:

- College of Engineering—all courses.
- College of Music
  - Music theory (prefix 71), all courses, except
  - 71-100 Basic Music Theory,
  - 71-101 Music Theory I.
  - Sound recording technology (prefix 78), all courses;
  - Music business (prefix 77), all courses;
  - Music education (prefix 73), all courses.
- College of Health Professions
  - Professional courses in all curricula;
  - Physical activity courses, except in satisfaction of the physical education requirement of the core curriculum.
- College of Management Science
  - *Liberal Arts students are permitted to elect a limited number of specified courses in the Departments of Accounting, Management, and Marketing. For a list of the specific courses which may be elected for degree credit in these departments, students may apply either to the chairperson of their major department or to the office of the Dean, College of Liberal Arts. Liberal Arts students who are contemplating enrolling in courses in these departments should carefully check the applicability of the proposed courses to College of Liberal Arts programs as well as their eligibility to enroll in these courses under College of Management Science regulations.*
- College of Education
  - Courses in Foundations of Education (prefix 01), offered by the College of Education, may be credited to degree programs in the College of Liberal Arts but enrollment in these courses normally requires permission of the Dean of the College of Education.

Transfer Policies

Students transferring to the College of Liberal Arts from other colleges of the University or from other institutions may expect recognition of previously completed college level courses which are applicable to the degree requirements of the college. The College of Liberal Arts will not accept in transfer professional courses from any program or curriculum whatsoever, with the exception of credits specifically applicable to the degree program in the administration of criminal justice. Courses of a professional nature which are not relevant to the academic orientation of liberal arts programs or to the specific orientation of the degree program in the administration of criminal justice may not be credited to the minimum degree requirement of 120 credits and irrespective of any previous recognition by the office of admissions or by other colleges of the University, they may not be credited to degree requirements in the College of Liberal Arts. (Professional courses of students who transfer to the University to the criminal justice program and who subsequently seek intercollegiate transfer to another degree program in the College of Liberal Arts will remain on the student's permanent record but will not be credited to minimum degree requirements.)

Transfer from Other Institutions

Courses which are transferred from other institutions are initially evaluated by the office of admissions when a student is admitted to the University. Courses are evaluated by major departments in terms of college and program requirements. Courses which are transferred to the University under provisions of the Commonwealth Transfer Compact, and which are not creditable to requirements of the College of Liberal Arts or as unrestricted elective courses will be listed on the student's permanent record but will not apply to the minimum degree requirements. In the event that a student who has transferred to the University subsequently makes an intercollegiate transfer to the College of Liberal Arts, all previously completed courses, including transferred courses from other institutions, will be reevaluated in terms of their applicability to degree requirements of the College of Liberal Arts. The policy of the College of Liberal Arts is to count courses transferred to the major for the purpose of determining the student's major grade-point average.

Repetition of Transferred Courses

A student who has been granted transfer credit, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred when the competence of the student has been demonstrably inadequate. Permission to repeat the transferred course is granted by filing an academic petition form through the office of the college dean. Since credit may not be granted more than once for the completion of any course; a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

Intercollegiate Transfer to the College of Liberal Arts

Students wishing to transfer from another college of the University or from baccalaureate continuing education programs of the Evening School must file an academic petition, together with a transcript, with the appropriate chairperson and the Dean of the College of Liberal Arts by November 1 for spring semester transfer and by April 1 for fall semester transfer. Students are referred to University policies concerning intercollegiate transfers which appear elsewhere in this publication under the heading "Academic Policies: Change of Major with Intercollegiate Transfer" for further procedural details. Records of students who are approved for transfer are reviewed by the office of the dean of the College of Liberal Arts and, irrespective of grades previously received in other college program, all courses which may not be applied to college or program requirements are deleted from the student's cumulative grade-point average.

PRE-PROFESSIONAL TRAINING

The curricula for the Bachelor of Arts degree in the College of Liberal Arts do not prescribe patterns of courses for specific vocational goals. The student in these programs receives a broad general education in the liberal arts and sciences which will prepare him/her for further study in professional and vocational fields at the graduate level. Since it is a part of the philosophy of the College of Liberal Arts that a liberal education is the best preparation for further study, the college does not recommend highly specialized courses for students planning to enter professional fields.

Law School Requirements

Pre-law work should include social sciences (especially history, economics and political science), humanities (especially literature and philosophy) and basic courses in physical sciences and mathematics. Law schools do not specify particular majors for applicants and the field of concentration is not a determinant in admissions. Law schools do, however, vary in specific requirements and the student should, therefore, become familiar with those requirements of the schools to which he or she is planning to apply.

Medical, Dental School Requirements

The Council and Association of American Medical Colleges have established minimum requirements for admission to an approved medical school. These include general and organic chemistry, biology, physics, and mathematics. These are minimums and many medical colleges require course work beyond the minimum. For this reason, it is imperative that a pre-medical student plan his/her college program in close consultation with the faculty advisor for pre-medical students. The advisor for pre-medical students is Dr. David Eberiel, Department of Biological Sciences, Olsen Hall.

Most medical and dental schools prefer a broad, liberal education in addition to specific course requirements. They do not advocate a particular major or majors and the field of concentration is not a determining factor in admission as long as the specified course requirements are met. Many pre-medical students will major in biology or chemistry, but a major in the areas of humanities, social sciences and the creative arts allow sufficient electives to meet the requirements of most schools. Medical and dental schools require an aptitude examination which is ordinarily taken in the spring semester of the junior year.

Business Administration

The liberal arts student planning graduate study in business (Master of Business Administration) should give consideration to the concentration in business skills which is detailed in the section entitled "Interdisciplinary Programs and Minors" at the end of this section of the catalog. This program emphasizes the courses and skills that are appropriate for students who desire to enter graduate business programs or to enter directly into business or industry on the completion of their undergraduate study.

Teaching Careers

For those students interested in teaching, the College of Education offers a graduate degree program designed to prepare elementary teachers and secondary teachers in art, English, mathematics, behavioral science, history, social studies, French, Spanish, biology, chemistry, earth science, and physics.

This year-long program (September to June) provides the course work and the apprentice teaching experience required for certification in Massachusetts and in thirty-three other states.

See graduate catalogue for requirements for admission.

Interested persons may obtain additional information from Dr. Gail M. Carney, Director of Field Experience, College of Education.

COLLEGIATE COURSES

41-400,405 EXTRAMURAL INTERNSHIP

A complement to formal classroom education which offers the student the opportunity to participate in a government agency, political organization or a professional setting for academic credit. Internship must be within or related to student's academic major or professional goals. Readings, reports, supervised on-the-job training, and evaluation required. Credits will be determined on a case by case basis. All credits will be counted toward graduation but not more than six toward fulfillment of major requirements. Prerequisites: twelve hours in major, junior or seniors in good academic standing, nomination by major department, and written authorization by the dean of the college. 6-15 cr.

COMMITTEE FOR AMERICAN STUDIES

Clifford Lewis, Coordinator

Professors: Charles F. Carroll (History), Clifford Lewis (English), Mary Roth Walsh (Psychology)

Associate Professors: Dean Bergeron (Political Science)

The Committee for American Studies administers a major in American Studies that leads to the Bachelor of Arts degree. The committee also administers a minor in American studies.

American Studies Major

American studies allows the student who is searching for an understanding of interrelationships among ideas, institutions, and aesthetic forms to combine a number of scholarly disciplines in order to better comprehend the many facets of modern American culture. Although the American studies program is not career oriented, the committee believes that students who combine a variety of disciplines will not only sharpen their analytical powers and increase their sense of self-fulfillment, but will, in the long run, be well prepared for employment in education, government, social services, business, and the professions. Students who are capable of analyzing American culture by combining the conceptual approaches of a variety of disciplines—the arts, history, literature, political science, psychology, economics, sociology—are capable of making decisions with some realization of the available alternatives. Many current problems relating to family life, medical ethics, the status of women and minorities, technology, the environment, international relations, government power, and the influence of big business, require an interdisciplinary approach. The American studies major is a method by which students can obtain a very broad liberal arts education. At the same time, the committee encourages students to elect career-oriented courses as free electives. A number of American studies majors take a portion of their free electives in studio art, accounting, management, economics, mathematics, and computer programming. Because of its flexibility, the American studies major is a good choice for students who are unsure about their ultimate career choice, for the program is flexible and allows for changes in career direction—often without an accompanying loss of time and course credits.

Major Requirements

To fulfill the requirements for a major in American studies, students must take 30-45 semester credits (with at least 15 credits at the 300 or 400 levels) including the following courses:

1. 43-305/306 American Intellectual History, or 43-313/314 American Social History.
2. An introductory research course approved by the coordinator.
3. One interdisciplinary 300 level course approved by the coordinator.
4. Two courses at the 300 level or above in one discipline.
5. Two courses at the 300 level or above in a second discipline.
6. 40-401 American Studies Seminar, preferably during the senior year.

Interdisciplinary Course Requirements

Students majoring in American studies must take at least one 300 level interdisciplinary course. Each of these courses integrates a number of academic disciplines and analyzes the multiplicity of forces that shape American culture.

Transfer Policy

Students transferring to the College of Liberal Arts and wishing to major in American studies must make individual arrangements with the coordinator of the program regarding credit for major and collateral course requirements. Some introductory courses at the 100 level may be applicable to the American studies major, but they cannot be applied to the first 30 hours of the major.

Minor Requirements

A minor in American studies consists of 18-24 credits selected from the list maintained by the program coordinator. These courses must include either: 43-305/306, American Intellectual History; or 43-313/314, American Social History; and at least one interdisciplinary course chosen from the list above.

American Studies (Course Prefix: 40)

40/42-248 VALUES IN AMERICAN CULTURE
This course deals with the development and evolution of American views on individualism, nature, science, technology, democracy, and the American Dream. The course shows how an evolving values system influences individual and national decisions. Readings include excerpts from the writings of Oppenheimer, short stories by Wharton and Hemingway, selections from the Puritans, essays on technology and democracy, autobiographical excerpts from the ex-slave, Frederick Douglass, and magazine articles on immigration, inventors and applications of democratic principles to the modern business community. Lewis. 3 cr.

Seminar

40-401 AMERICAN STUDIES SEMINAR
A required seminar for American studies majors, normally taken during the second semester of the junior year, or during the senior year. Students undertake a research project leading to the writing of a major paper with a theme that combines more than one discipline. Carroll, Lewis. 3 cr.

Directed Studies

Directed studies courses are available only to majors in American studies and may be elected provided that 1) the material to be covered is not available in any course offered during the semester in which the directed studies course is contemplated, 2) instructors are willing to undertake a directed studies course, and 3) no more than 9 credits in the major field are acquired in directed studies courses.

40-491 DIRECTED STUDIES IN AMERICAN STUDIES
An investigation of a topic using an interdisciplinary approach and leading to the writing of a major paper. The course provides an opportunity for a student to work closely with an instructor on a topic of special interest. Prerequisite: 40-401, and permission of program coordinator and instructor. Carroll, Lewis. 3 cr.

40-495 ADVANCED TUTORIAL IN AMERICAN STUDIES
A program of directed studies in which the student, in consultation with the instructor, investigates one or more topics and presents several critical essays that evaluate the readings. Prerequisite: demonstrated proficiency in the areas selected for study, and permission of the instructor. Carroll, Lewis. 3 cr.

Practicum

40-496 PRACTICUM EXPERIENCE IN AMERICAN STUDIES
The practicum experience allows students an opportunity to combine their formal education with an off-campus project. After developing a proposal for the practicum under the guidance of an instructor, the student spends a major portion of his or her time dealing with persons engaged in business, the arts, the professions, community service, or government. The coordinator for American studies maintains a file of organizations that accept students. 3 cr.

DEPARTMENT OF ART

Chairperson, Liana Cheney

Professors: Liana Cheney, Fred Faudie, Brenda Pinardi

Associate Professors: James Coates, Robert Griffith, Arno Minkkinen

Assistant Professor: James Veatch

Art Major

The art major is designed to develop a discriminating appreciation of the art world and a knowledge of the technical requirements for creating art works. In order to foster these abilities and to promote analytical and aesthetic understanding, the program provides a foundation in both the theoretical and practical aspects of art. The Department of Art offers the professional degree of Bachelor of Fine Arts. It also offers a major in art leading to the Bachelor of Arts degree; students in the Bachelor of Arts program may elect an option in either general art or studio art. The department offers minor programs in art history and in studio art. A major in art provides students the opportunity to prepare for careers in fine arts, commercial art, community oriented programs, gallery work, museum research, photography related occupations, teaching, and for graduate programs in art history, art education and studio art.

Bachelor of Fine Arts

This professional degree program is intended for students who possess special talent, creativity and dedication and who seek practical knowledge of the basic art processes and the opportunity to develop and refine their abilities in one of the two areas of concentration: fine arts or graphic design. By choosing this program the student prepares for a commercial art career or for graduate study in studio art. All students must complete the required minor in art history. The total semester credits in art courses, including both studio and history courses, may not exceed 90 unless the student presents additional non-art credits (equal to the number of semester credits by which they exceed the 90 credit maximum in art) beyond the minimum degree requirement of 126 semester credits. In all cases, BFA degree candidates must present a minimum of 36 semester credits in non-art courses.

Students who wish to pursue the Bachelor of Fine Arts degree must submit to the department chairperson a formal letter of application to the BFA program and, in addition, meet the following standards:

1. Completion of the Art Department basic studio course requirements (6 courses, 18 semester credits);
2. Additional upper level studio art courses, selected in consultation with the academic advisor and which are appropriate to the intended concentration;
3. Maintain a semester grade point average of 2.50 (on a 4.00 scale) for all art courses.

Students who have satisfied these requirements are permitted to enroll in the first course in Senior Studio (3 semester credits) as *a conditional student* in the BFA program. A grade of B/C or better in the Senior Studio is a prerequisite to continued matriculation in the program.

Students who have matriculated in the BFA program must maintain an average of B/C (2.50) or better in the remaining 18 semester credits of senior studio courses, and must receive a recommendation for continuance from the senior studio review committee at the end of *each semester* of enrollment in Senior Studio.

A student who fails to maintain the required grade point average or who is not recommended for continuation by the review committee will be dismissed immediately from the BFA program.

Senior Studio courses are, with the exception of the first conditional 3 credit course, regarded as professional courses and for this reason are restricted to matriculating BFA majors only and may not be credited to any other curriculum. In the event that a matriculating BFA student transfers or is dismissed from the BFA program, semester course credits earned in subsequent senior studio courses may not be credited to degree programs either in the Art Department or elsewhere in the University. Senior students should be aware that transferring from the BFA program to another degree major will normally entail a loss of credits and that the completion of degree requirements within the customary four year period may not be possible.

The studio art requirement of the BFA curriculum consists of 72 semester credits, as specified:

1. Basic studio courses: six courses (18 semester credits)*
    - 57-241 Visual Design I
    - 57-253 Three Dimensional Design
    - 57-255 Drawing I
    - 57-261 Photography I
    - 57-267 Printmaking I
    - 57-271 Painting I
2. Eleven courses (33 semester credits) in the chosen concentration of fine arts or illustration. The courses listed below are typical, but individual programs may be structured differently with the consent of the advisor and senior studio review committee. Students may petition to elect up to three courses (9 semester credits) in other departments.
    - a. Fine arts concentration:
        - 57-269 Color Studio
        - 57-297 Studio Workshop
        - 57-355 Drawing II Studio
        - 57-357 Figure Drawing Studio
        - 57-361 Photography II Studio
        - 57-367 Printmaking II Studio
        - 57-371 Painting II Studio
        - 57-273 Water Media Studio
        - 57-275 Sculpture I Studio
        - 57-375 Sculpture II Studio
        - 57-491 Advanced Painting Studio
    - b. Graphic design concentration:
        - 57-230 Lettering Studio
        - 57-269 Color Studio
        - 57-297 Studio Workshop
        - 57-351 Visual Design II
        - 57-355 Drawing II Studio
        - 57-357 Figure Drawing Studio
        - 57-361 Photography II Studio
        - 57-368 Silkscreen Studio
        - 57-372 Cartooning Studio
        - 57-390 Illustration Studio
        - 57-395 Advertising Design Studio
3. Senior studio: 7 courses (21 semester credits)
Courses under this requirement are taken only with the consent of the student's academic advisor and of the senior studio review committee.

57-492 Advanced Studio (two courses from selected concentration)	6 cr.
57-497 Senior Studio (last semester of junior year)	3 cr.
57-497 Senior Studio (first semester of senior year)	6 cr.
57-497 Senior Studio (last semester of senior year)	6 cr.

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* All art majors must successfully complete the following courses prior to enrolling in any other art course: 57-241 Visual Design I, 57-255 Drawing I, 58-203 Survey of Art I, and 58-204 Survey of Art II.

The art history requirement consists of 6 courses (18 semester credits):

58-203 Survey of Art I, Prehistoric to Medieval Art*
58-204 Survey of Art II, Renaissance to Modern*
Four art history electives (12 semester credits) of which at least 6 credits must be at the 300 level or above.

Bachelor of Arts: Major Requirements

General Art Program

This program is general in nature and includes courses in both studio art and in art history, and is sufficiently flexible so that students who desire to complete a second major in another discipline may do so. By pursuing a degree program which includes majors in both art and a second discipline, the student can prepare for graduate studies in art history or for work in related fields, such as a museum curator, museum conservator or slide librarian.

A major in general art consists of 36-45 credits, including:

1. Basic studio art courses: five courses (15 semester credits)* 57-255 Drawing I, 57-251 Design I, 57-271 Painting I, 57-261 Photography I, and 57-267 Printmaking I;
2. Four art history courses (12 credits)* 58-203 Survey of Art I, 58-204 Survey of Art II and two other art history electives;
3. Art electives (9-15 semester credits)
4. Senior Seminar (3 semester credits)

Studio Art Program

This program is designed for students who seek both knowledge of the basic art processes and an opportunity to develop skills in one of the following studio art areas: drawing and painting, illustration and design, or sculpture and ceramics. By pursuing a studio art major, the student can prepare for specific art careers and for graduate study in studio art. In addition to satisfying the requirements for the studio art major, students who pursue this option are also required to complete requirements for a minor in art history. These combined studies cannot exceed 63 semester credits unless the student presents an additional number of semester credits beyond the 120 credit minimum for the Bachelor of Arts degree which is equal to the number of credits by which he or she exceeds the specified 63 credit maximum. A minimum of 57 semester credits must be presented in non-art courses.

The major in studio art consists of 36-45 semester credits and must include:

1. Basic studio art courses: six courses (18 semester credits)* 57-255 Drawing I, 57-241 Visual Design I, 57-253 Three Dimensional Design, 57-271 Painting I, 57-261 Photography I, and 57-267 Printmaking I*
2. Four approved courses in one of the following areas of studio emphasis (12 semester credits)
    a. Drawing and Painting
    b. Illustration and Design
    c. Sculpture and Ceramics
3. Studio art electives (6-12 credits)
4. At least 5 courses (15 semester credits) must be at the 300 level or above
5. Senior Seminar (3 semester credits)

* All art majors must successfully complete the following courses prior to enrolling in any other art course: 57-241 Visual Design I, 57-255 Drawing I, 58-203 Survey of Art I, and 58-204 Survey of Art II.

The required minor in art history consists of 18-24 credits and must include at least six credits at the 300 level or above plus the following requirements:

1. Survey of Art I and II (6 credits)*
2. Art history electives (12-18 credits)

Portfolio Requirements

Freshman students and students without college level art credits who wish to enter one of the degree programs in the Art Department need not present a portfolio. Students who wish to transfer art credits to the department and to major in art must make individual arrangements with the chairperson regarding satisfaction of major course requirements. These students must arrange to present a portfolio of representative work which they have executed at their previous institution for review by the Department of Art for the purpose of determining which courses and credits the department will credit toward a University of Lowell degree.

Minor Requirements

A minor in studio art consists of 18-24 semester credits selected in accordance with the following specifications: 15-21 credits must be completed in studio art courses, at least one course must be completed in art history, and no fewer than six semester credits offered for the minor shall be completed at the 300 level or above.

A minor in art history consists of 18-24 semester credits selected in accordance with the following specifications: 15-21 credits must be completed in art history courses, at least one course must be completed in studio art, and no fewer than six semester credits offered for the minor shall be completed at the 300 level or above.

Summer Program Abroad

The department offers art history courses for credit in Europe during the summer. Interested students should contact the department chairperson.

Student Policies

Registration for Art Courses

The Department of Art reserves the right to preregister its major students in order to assure completion of their degree requirements. In the event of over-subscription of art courses by art majors, the department will grant first preference to seniors and second preference to juniors.

Policy Concerning Student Work

The Department of Art reserves the right to keep student work for a period not to exceed one year for inclusion in exhibitions.

The department reserves the right either to photograph student work for its slide collection or, in the case of photography and printmaking courses (where many copies can be made), to keep actual examples of work.

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* All art majors must successfully complete the following courses prior to enrolling in any other art course: 57-241 Visual Design I, 57-255 Drawing I, 58-203 Survey of Art I, and 58-204 Survey of Art II.

Unless otherwise specified, art work and term papers left for more than one semester following the semester in which they were completed become the property of the department.

Academic Integrity

Students should be aware of the issues of creative honesty and dishonesty, the prohibition against the unwarranted use of the work of others and the misrepresenting of the source of work and ideas, and the penalties established by the University for cheating and plagiarism. The department expects that work passed in by the student will be the product of the student's own effort. Particulars of the University policy on academic dishonesty can be found elsewhere in this bulletin.

Equipment Care and Replacement Repair

The Department of Art has limited resources which allow it to provide equipment for student use. Students are responsible for replacement costs of any items which they lose or damage in the course of their studies.

Laboratory Fees

Studio courses with 800 section numbers require payment of a laboratory fee.

Art Studio (Course Prefix: 57)

57-230 LETTERING STUDIO
The study of lettering concepts and techniques, including the history of letters, styles and families of type, letter design, hand drawn, mechanical, and machine lettering approaches and their effect and uses in communication. Emphasis will be on creative and aesthetic communication. Panas, Staff. Fall. 3 cr.

57-251 VISUAL DESIGN I
A study of design principles and how they articulate structure, space, and form. The development of visual ideas that relate to painting, sculpture, graphic arts and architecture. Griffith. Fall, Spring. 3 cr.

57-253 THREE DIMENSIONAL DESIGN
A study of the visual elements and the basic design principles involved in the composition of three-dimensional objects. Emphasis will be placed on materials exploration, the development of problem-solving skills, perception, awareness and sensitivity to our visually, object oriented environment. Coates. Fall, Spring. 3 cr.

57-255 DRAWING I
A foundation course in basic drawing concepts using a variety of media and approaches. The emphasis is on realism and its application to the realm of ideas. A wide range of assignments are given to develop graphic expression.
Coates, Faudie, Pinardi. Fall, Spring. 3 cr.

57-261 PHOTOGRAPHY I
An introduction to photography with an emphasis on photographic composition and pictorial elements. Basic darkroom techniques for black and white photography will be covered. Students learn to develop and print black and white photographs. Faudie.
Fall, Spring. 3 cr.

57-265 ART WITH THE COMPUTER
An aesthetic and communications oriented course using the computer as the primary tool for translating art ideas into physical form. The emphasis will be on practical usages of

existing Macintosh software as a means of creation. Techniques will center on utilizing the existing hardware and software rather than writing new programs. Prerequisite: 57-251 and/or 57-255 or permission of the instructor. Faudie. Fall. 3 cr.

57-267 PRINTMAKING I

An introduction to graphic techniques and expression, including relief and intaglio processes. The approach is creative rather than directed, emphasizing experimentation and exploration in many areas of printmaking. Griffith, staff. Fall. 3 cr.

57-269 COLOR STUDIO

A course in the systematic study of color and color theory to sharpen visual acuity, stimulate creativity, and develop a greater facility in the use of color. Griffith. Spring. 3 cr.

57-271 PAINTING I

Oil painting techniques are taught as vehicles for serious creative expression. A variety of assignments will be given to help the student gain proficiency in the use of color, technique and subject matter. Panas, Pinardi. Fall. 3 cr.

57-273 WATER MEDIA STUDIO

Technical and creative exploration of various types of water media including acryllic, gouache, watercolor and other related techniques. Faudie, Pinardi. Spring. 3 cr.

57-275 SCULPTURE I STUDIO

The exploration of three dimensional form through the use of basic materials, methods and approaches. Assignments will include expressive problems based on human and non-objective form relationships. Coates. Fall, alternate years. 3 cr.

57-281 CERAMICS I STUDIO

Introduces the student to basic handbuilding techniques, wheel throwing and ceramincs sculpture; examines the nature and properties of clay, glaze and glazing techniques, and the firing process. Coates. Fall, alternate years. 3 cr.

57-297 STUDIO WORKSHOP

Study of studio problems in visual structures and organization, and exploration of various media and techniques. Topics will vary. This course may be repeated. Prerequisite: 57-251, 57-253, and/or 57-255 or permission of instructor. Staff. Fall, Spring. 3 cr.

57-351 VISUAL DESIGN II STUDIO

An advanced study of design principles and how these articulate structure, space and form. The emphasis is on development of a personal approach to design principles. Prerequisite: 57-251 or permission of instructor. Griffith. Spring. 3 cr.

57-355 DRAWING II STUDIO

An advanced course in drawing and an outgrowth of Drawing I. The course includes a wide range of media and subject matter with emphasis on development of personal expression and style. Drawing on location, weather permitting, and working in a studio situation with models and still life will constitute a major portion of this course. Prerequisite: 57-255 or permission of instructor. Pinardi. Spring. 3 cr.

57-357 FIGURE DRAWING STUDIO

Emphasis is on drawing the draped and undraped figure, stressing sound observations and effective creative presentation. Development of personal style is emphasized. Prerequisite: 57-255 or permission of instructor. Pinardi. Fall, alternate years. 3 cr.

57-359 SCULPTURE II STUDIO

A course allowing the student to further develop his or her techniques and understanding of sculptural form, leading to a more personal vocabulary. Conventional techniques will be extended to cover more contemporary materials and methods. Prerequisite: 57-275 or permission of instructor. Coates. Spring, alternate years. 3 cr.

57-361 PHOTOGRAPHY II STUDIO

Advanced black and white techniques, introduction to use and development of color, and help in developing a personal photographic vision. Prerequisite: 57-261 or permission of instructor. Faudie. Spring. 3 cr.

57-363 FILM MAKING

An introduction to making movies structured upon inexpensive super-8 equipment and basic video equipment. Aspects of basic camera use, composition, lighting, animation and similar elements will be covered. Essential equipment is furnished. Prerequisite: 57-261 and/or 57-361 or permission of instructor. Faudie. Spring, alternate years. 3 cr.

57-367 PRINTMAKING II STUDIO

Advanced work on printmaking including etching, intaglio, lithography, and other techniques. Students are encouraged to explore several media in depth. Prerequisite: 57-267 or permission of the instructor. Griffith, staff. Spring. 3 cr.

57-368 SILKSCREENING STUDIO

A course in the fundamentals of silk screen process. Techniques will include paper and film stencil and photographic process. Students are encouraged to explore subject matter and images through imagination and to develop competency in color mixing and in making silk screen prints. Griffith. Spring. 3 cr.

57-371 PAINTING II STUDIO

The course is designed to allow students to develop individual style through a variety of problems, both self-initiated and assigned by the instructor. Faudie, Pinardi. Spring. 3 cr.

57-372 CARTOONING STUDIO

The course is designed to develop skills and techniques essential for appreciating and producing cartoon forms for publication and advertising. Special topics to be covered are politics, sports, panel humor, advertising and comic strips. Original cartoon work will be done in black and white, and color; using overlays, hand and transfer lettering. Prerequisite: 57-255 or permission of instructor. Panas. Spring. 3 cr.

57-390 ILLUSTRATION STUDIO

This course provides students with a variety of experiences involving skills and techniques related to the execution of illustrations for children's books, fashion drawings, record albums, book jackets, folders, posters, and magazines. Field trips, discussions of job opportunities and preparation of portfolios are integral parts of the syllabus. Prerequisite: 57-251, 57-255, and/or 57-273 or permission of the instructor. Faudie, Panas. Fall. 3 cr.

57-395 ADVERTISING DESIGN STUDIO

Instruction in lettering, layout of commercial media as well as in the creative aspects of advertising are an integral part of the course. Practical problems, field trips and technical guidance from preliminary layouts to finished work will help prepare students for the commercial art field. Prerequisite: 57-230, 57-251, 57-255, and/or 57-261 or permission of instructor. Faudie, Panas. Fall, alternate years. 3 cr.

57-492 ADVANCED STUDIO

Those students who have successfully completed the most advanced course in a studio area may enroll in this course to pursue further creativity and technique in that area. Students will enjoy considerable freedom in planning and carrying out projects and are expected to perform at a correspondingly higher level. Prerequisite: permission of the instructor. May be repeated up to a total of 9 credits. Fall, Spring. 3 cr.

57-493 SENIOR SEMINAR
A required course for all BA students in both the General Art and Studio Art programs. The course explores asthetic and technical concepts through the completion of a project dealing with either a studio or art historical issues. Projects are designed in accordance with individual student interests in close cooperation with the seminar instructor. The course is normally taken during the final semester of enrollment. Staff. Spring. 3 cr.

Directed Studies

Directed study courses are available only to art majors and may be elected provided that (1) the material to be covered is not available in any course offered during the semester, (2) instructor is willing to undertake a directed studies course, and (3) no more than six hours of credit in the major field is earned through directed studies courses.

57-494 DIRECTED STUDY IN STUDIO ART
A special problem in studio art is investigated through conference and studio work. Prerequisite: permission of instructor. 3 cr.

57-495 ADVANCED TUTORIAL IN STUDIO ART
A program of directed studies which afford the advanced students with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. The purpose is to sharpen and refine skill, content and presentation. Prerequisites: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

57-496 PRACTICUM EXPERIENCE IN STUDIO ART
A program of on-campus and/or off-campus experiences for art majors only. Specific requirements will vary depending upon departmental policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural or artistic area and/or for learning of skills through temporary placement in the field. All practicum experiences must be approved by the Department of Art, and may be repeated to a maximum of nine credit hours. Practicum experience may not be substituted for a required course in the major. Prerequisite: permission of department chairperson and supervising instructor. 3 cr.

57-497 SENIOR STUDIO
The culmination of four years of studio experience for BFA students. The development of a personal approach to media and idea is emphasized. Each student will be responsible for designing and creating a project or series of works which develops a theme of his or her choice. No assignments will be made by the instructor who will act only as an advisor and coordinator. The course grade will be assigned by a committee of faculty members. Enrollment is restricted to majors in the BFA program. May be repeated up to a total of 15 credits. 3 cr.

Art History (Course Prefix: 58)

58-101 ART APPRECIATION
The course introduces the student to the fine arts and to important writings in aesthetics. An analysis of the visual elements used in fine art such as color, line, shape, texture, and value is developed through slide lectures, museum visits and assigned readings. Emphasis

is placed on modes of representation, styles, media, technical procedures, and principles of design. Staff. Fall, Spring. 3 cr.

58-203 SURVEY OF ART I

A survey of the major Western arts from earliest time to the Middle Ages presented chronologically. Emphasis is placed upon the changing nature of the style and content within sequential cultural contexts. The aim of the course is to introduce the student to basic critical and art historical methods. First semester. Cheney. Fall. 3 cr.

58-204 SURVEY OF ART II

A survey of the major Western arts from the Renaissance to the 20th century presented chronologically. Emphasis is placed upon the changing nature of the style and content within sequential cultural contexts. The aim of the course is to introduce the student to basic critical and art historical methods. Second semester. Cheney. Spring. 3 cr.

58-211 NINETEENTH CENTURY ART

A study of 19th century European painting, sculpture, and architecture including the art of Neoclassicism, Romanticism, Realism, Impressionism, Post-Impressionism, Symbolism and Art Nouveau. Cheney. Fall, alternate years. 3 cr.

58-221 TWENTIETH CENTURY ART

A study of American and European movements in painting, sculpture and architecture from 1900 to the present. Emphasis is placed on Fauvism, Cubism, Expressionism, Surrealism, International Style, Pop, Op Art, Minimal Art, Photorealism and Post-Modernism. Cheney. Spring, alternate years. 3 cr.

58-225 HISTORY OF PHOTOGRAPHY

A survey of photography with emphasis on key figures in its development. Photography is treated as an art-form and is compared to related non-photographic art movements. Includes the beginnings of the moving-picture phenomena. Staff.
Spring, alternate years. 3 cr.

58-231 GREEK AND ROMAN ART

A study of Greek painting, sculpture and architecture from the Cycladic to the Hellenistic period, and an examination of Roman Art from the Etruscan age to the beginning of Christian art. Emphasis is placed on the art of the Greek classical period and the Roman Empire. Cheney. Fall, alternate years. 3 cr.

58-241 MEDIEVAL ART

A survey of architecture, sculpture and painting of early Christian, Byzantine, Carolingian, Romanesque and Gothic periods from the 4th to the 13th centuries. Emphasis on Hagia Sophia, Aachen Chapel, Saint Denis and the French cathedrals. Cheney.
Spring, alternate years. 3 cr.

58-313 AMERICAN ART

The study of American painting, sculpture and architecture from the colonial period to the end of the 19th century seen in relation to European developments and American social and technological changes. Emphasis is placed on New England architecture. Prerequisite: 58-101 and/or 58-211 or permission of instructor. Cheney. Fall, alternate years. 3 cr.

58-321 ITALIAN RENAISSANCE ART

A study of painting, sculpture and architecture in Florence, Rome and Venice during the 15th and 16th centuries. Special emphasis on the formation of the High Renaissance style and the role of representative artists of the period: Leonardo, Michelangelo and Raphael in central Italy; Giorgione and Titian in Venice. Prerequisite: 58-101 and/or 58-204 or permisison of instructor. Cheney. Fall, alternate years. 3 cr.

58-323 NORTHERN RENAISSANCE ART

Development of Flemish and Dutch painting from the brothers van Eyck and Roger van der Weyden to Bosch and Breughel, from the late 14th century to mid-16th century. The course will also include a study of French and German painters of the same period: Fouquet, Clouet, Durer, Grunewald and Holbein. Prerequisite: 58-101 and/or 58-204 or permission of instructor. Cheney. Spring, alternate years. 3 cr.

58-332 BAROQUE ART IN ITALY

The development of painting, sculpture and architecture in Italy during the 17th century with special emphasis on Rome. The role of representative artists (Caravaggio, Bernini, Borromini, Pietro da Cortona) is emphasized. Prerequisites: 58-101 and/or 58-204, 58-321 or permission of instructor. Cheney. Fall, alternate years. 3 cr.

58-334 NORTHERN BAROQUE ART

The examination of 17th century painting outside Italy with emphasis upon Dutch, Flemish, Spanish and French art. The role of representative artists of the period (Rembrandt, Rubens, Velazquez and Poussin) is emphasized. Prerequisite: 58-101 and/or 58-204, 58-323 or permission of instructor. Cheney. Spring, alternate years. 3 cr.

58-340 WOMEN AND ART

Investigation of the various ways women have been portrayed in the visual arts from antiquity to the present. A chronological examination of selected female artists and their milieu from the Middle Ages to the 20th century. Prerequisite: 58-101 and/or 58-203, 58-204 or permission of instructor. Cheney. Spring, alternate years. 3 cr.

58-350 POST-MODERNISM IN ART AND ARCHITECTURE

The course will explore crucial issues of contemporary art, examining in detail particular artists, art forms and critical concepts. The study will cover art movements from the 1960's to the present in painting, sculpture and architecture. Prerequisite: 58-221 or permission of instructor. Cheney. Fall, alternate years. 3 cr.

58-490 ART HISTORY SEMINAR

Study of particular artist, style or selected art historical problem. Topics to be announced. Course may be repeated. Prerequisite: permission of instructor. Cheney.
Fall, Spring. 3 cr.

Directed Studies

Directed study courses are available only to art majors and may be elected provided that (1) the material to be covered is not available in departmental course offerings, (2) instructor is willing to undertake a directed study course, and (3) no more than 6 hours of credit in the major field is acquired through registration for and completion of directed study courses.

58-494 DIRECTED STUDY IN ART HISTORY

An individual supervised research project relating to stylistic, thematic or methodological issues in art history, the result to be presented in a significant paper. Prerequisite: permission of instructor. 3 cr.

58-495 ADVANCED TUTORIAL IN ART HISTORY

A program of directed studies which affords the advanced student with an additional opportunity to pursue a previously explored problem in greater depth or to initiate and investigate an additional problem. The purpose is to sharpen and refine skills for scholarly research and presentation. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

58-496 PRACTICUM EXPERIENCE IN ART HISTORY
A program of on-campus and/or off-campus experiences for art majors only. Specific requirements will vary depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural or artistic area and for applying techniques of problem solving and/or credits. Students will be graded "satisfactory" or "unsatisfactory". The practicum experience may not be substituted for a required course in the major. Prerequisite: permission of the department chairperson and supervising instructor. 3 cr.

DEPARTMENT OF CRIMINAL JUSTICE

Joseph Lipchitz, Chairperson

Professors: Alan Lincoln, Joseph Lipchitz

Associate Professors: Eva Buzawa, James Byrne, June Gonsalves, Renee Kasinsky

Assistant Professor: Gerald Hotaling

The Criminal Justice Major

The curriculum in criminal justice leads to the degree of Bachelor of Science in Public Service: the Administration of Criminal Justice. This program offers a strong concentration in professional courses while simultaneously providing the student with a well-rounded liberal arts education. Typically, the criminal justice major takes between 36 and 45 credits in professional courses and an additional 15 credits in collateral liberal arts courses programatically related to the major course of study.

Additionally, the criminal justice major must satisfy a professional skills requirement, consisting of either intermediate proficiency in a modern foreign language or a sequence of courses in computers and mathematics.

Basic Requirements

The major in criminal justice consists of at least 36 credits, at least 15 credits of which shall be at the 300 course level, or above.

1. All students are required to take the following major courses (18 credits):

   44-101 The Criminal Justice System
   46-230 Law and the Legal System
   44-221 Criminology I
   44-390 Introduction to Criminal Justice Research
   44-490 Criminal Justice Research Seminar
   44-496 Criminal Justice Practicum

   Five courses (15 credits) must be selected and passed from the following list of courses offered by other departments. Credits for these courses will be applied to the major.

   43-308 History of Crime, Conflict and Social Control in the United States
   43-340 Foundations of Anglo-American Law
   46-230 Law & the Legal System (required for CJ majors)

46-345 Constitutional Law and Politics
46-347 Civil Liberties, Law and Politics
46-356 Public Policy Analysis
46-360 Public Administration
47-364 Psychology of Crime and Corrections
48-255 Sociology of Deviance
48-361 Sociology of Law & the Criminal Justice System

2. All students must meet proficiency standards in one or the other of the following skill areas:

   a. Intermediate proficiency in a modern foreign language, usually Spanish. (Refer to Language Proficiency Requirement of the College of Liberal Arts in this bulletin for a listing of the ways in which this requirement may be satisfied.)

   b. Proficiency in computer programming and statistics which is demonstrated by passing at least four courses (12 credits) from this list of courses:

   The student shall elect one of the following:

   92-209 Introduction to BASIC
   92-219 BASIC Programming, or
   92-242 Business Applications of BASIC;
   plus one of these courses:
   92-263 FORTRAN Programming
   92-265 PASCAL, or
   92-365 COBOL;
   plus
   92-383 Introduction to Statistics
   and either
   92-363 Data Analysis, or
   43-335 Quantitative Methods in History and the Social Sciences.

3. Collateral requirements. Students must pass six courses (18 credits) from an approved list of correlative courses. Certain of the skill courses (above) may be used toward fulfillment of this requirement. Approved correlative courses include:

   43-243 American Urban History I
   43-244 American Urban History II
   43-268 History of the Family and Childhood in the United States
   43-335 Quantitative Methods in History and the Social Sciences
   45-203 Introduction to Ethics
   46-202 Practical Public Affairs
   46-265 State and Local Politics
   46-270 Legislative Politics
   46-355 Government Fiscal Policy
   47-209 Social Psychology
   47-232 Psychology of Personality
   47-262 Adolescent Psychology
   47-272 Abnormal Psychology
   48-231 Sociology of the Family
   48-234 Study of Minorities

48-235 Black Experience in American Life
48-256 Political Sociology
48-341 Social Stratification
48-345 Urban Sociology
92-209 Introduction to Basic
92-219 Basic Programming
92-242 Business Applications of Basic
92-263 Fortran
92-265 Pascal
92-363 Data Analysis
92-383 Introduction to Statistics

Optional concentrations within the criminal justice major are available in the three areas of enforcement, corrections, and law and the court system. Students interested in pursuing one of theses concentrations should contact the department chairperson.
The majority of criminal justice courses are regarded as professional courses and, except for those listed below, are not accepted either in transfer nor as elective options in other degree programs in the College of Liberal Arts. These courses are open as electives to non-majors (on a space-available basis) and will count toward a Bachelor of Arts degree if a criminal justice student changes his/her major within the College of Liberal Arts:

44-101 The Criminal Justice System
44-221 Criminology I
44-261 Juvenile Delinquency
44-321 Criminology II
44-342 The British Criminal Justice System
46-230 Law and the Legal System

Students who transfer to the criminal justice major or to the College of Liberal Arts with the intention of subsequently declaring a major in criminal justice must make individual arrangements with the department chairperson regarding satisfaction of major and collateral course requirements.

Students wishing to prepare themselves as completely as possible should consider the possibility of selecting a minor or second major in a field of their choice.

Master of Science in Criminal Justice

The department also offers a Master of Science degree in Criminal Justice. For information on the objectives and requirements of this program, consult the "Bulletin of Graduate Studies".

Criminal Justice (Course Prefix: 44)

44-101 THE CRIMINAL JUSTICE SYSTEM (3,0)3
The course includes a brief history of the criminal justice system and an analysis of its structure and function. This course is required for all majors and is a prerequisite for all other courses in criminal justice.

44-141 POLICE FUNCTIONS: THEORY AND APPLICATION (3,0)3
An examination of the historical development of police work with special emphasis on the conflicting role expectations facing the police officer.

44-151 INTRODUCTION TO CORRECTIONS **(3,0)3**

A comprehensive view of the theory, practice and philosophy involved in the treatment of convicted law violaters of all ages.

44-221 CRIMINOLOGY I **(3,0)3**

The definition and nature of crime, criminal statistics, and a survey of theories of the cause of crime. Required of all majors.

44-233 CRIMINAL PROCEDURE **(3,0)3**

This course deals with the workings of the legal system as they pertain to the criminal justice professional. Particular emphasis will be placed on the proper legal procedures leading up to and including court proceedings.

44-234 CRIMINAL LAW **(3,0)3**

The historical origins and development of criminal law from the early common law to contemporary decisions and statutes. Constitutional and statutory factors as they pertain to crime, defense, and crimes against persons and property will be considered. In addition, attention is directed toward limitations of criminal responsibility, capacity and the law of arrest. Sections of the Massachusetts Criminal Code and other statutes will be covered where applicable.

44-243 CRIMINALISTICS I **(3,0)3**

This laboratory course will cover basic procedures of arrest, search, and seizure, and the gathering of evidence and its evaluation in terms of admissibility, weight, and competence. Prerequisite: 2 semesters of science.

44-244 CRIMINALISTICS II **(3,0)3**

This laboratory course concerns the collection, identification, preservation and transportation of physical evidence. The crime laboratory and its effectiveness, capabilities and limitations in assisting the police officer in utilizing physical evidence as a means of apprehension and/or conviction will be carefully examined. Prerequisite: 44-243.

44-261 JUVENILE DELINQUENCY **(3,0)3**

Causative factors in the development of youthful offenders will be examined. The development and philosophy of juvenile courts; clinical treatment, training schools, and contemporary innovative practices will be covered.

44-321 CRIMINOLOGY II **(3,0)3**

An examination of theories of criminal behavior, both historical and contemporary, and their impact on the evolution of punishment, treatment and rehabilitative practices.

44-331 PENAL LAW **(3,0)3**

A study of the constitutional rights of incarcerated individuals, including major policy issues and trends associated with recent revisions of penal codes which reflect court decisions for the preservation of offenders' rights.

44-335 JUVENILE COURT-PHILOSOPHY AND PRACTICE **(3,0)3**

An examination of the civil procedures used in juvenile court as opposed to the adversarial procedures used in criminal court, together with a history of the development of the juvenile court and an examination of its constitutional basis. Prerequisite: 44-261.

44-341 COMPARATIVE POLICE SYSTEMS **(3,0)3**

A study of various police systems on the national and international level and a comparison with local systems on the basis of organization, structure, and administration of law enforcement. Agencies in Great Britain, France, the Soviet Union and the United States will be examined.

44-342 THE BRITISH CRIMINAL JUSTICE SYSTEM (6,0)6
This study of the British criminal justice system is offered summers in conjunction with the faculty of Oxford University. The program includes travel and intensive lectures on the various aspects of the British criminal justice system. Lectures by Oxford University faculty will be coordinated with visits to agencies and institutions. Oxford University's library resources will be available to the student to help in the preparation of a required research paper.

44-351 ALTERNATIVES TO CORRECTIONS (3,0)3
Modern trends in corrections, such as community based programs in work-release, halfway houses, parole clinics, the theraputic community, and team treatment concept in institutions are studied and evaluated. Prerequisite: 44-151.

44-354 PROBATION AND PAROLE (3,0)3
The historical development of both probation and parole, and an examination of their place in the criminal justice system. There will be an emphasis on recent trends including diversion, flat sentencing, weekend sentencing, and issues associated with this departure from traditional practice.

44-360 MINORITIES, LAW AND JUSTICE (3,0)3
Both the social and legal consequences of racism and discrimination will be discussed as they pertain to minorities and the working of the criminal justice system. The course presupposes some legal knowledge and basic skills in legal reasoning. The listed prerequisites are therefore not waivable. Prerequisites: 44-234, 46-345, or 46-347.

44-370 CRIMINAL JUSTICE MANAGEMENT (3,0)3
An introduction to the principals of administration, including planning, budgeting, grantsmanship and evaluation, as they relate to the criminal justice manager.

44-371 CRIMINAL JUSTICE PLANNING (3,0)3
A continuation of criminal justice management with particular emphasis placed upon student design and evaluation of programs and plans. Prerequisite: 44-370, or equivalent.

44-372 ISSUES IN CORRECTIONAL ADMINISTRATION (3,0)3
Specific analysis of the management of correctional institutions, including custody, classification, reception, programming, release, staffing, scheduling, collective bargaining, and other related issues. Prerequisite 44-370 or equivalent.

44-373 ISSUES IN POLICE ADMINISTRATION (3,0)3
Specific analysis of the management of contemporary police forces, including staffing, scheduling, training, collective bargaining, community relations, and other related issues. Prerequisite 44-370 or equivalent.

44-380 SELECTED ISSUES IN CRIMINAL JUSTICE (3,0)3
An advanced course of study and examination of a variety of current issues and topics in criminal justice. Restricted to C.J. majors with senior status.

44-390 INTRODUCTION TO CRIMINAL JUSTICE RESEARCH (3,0)3
An introduction to research methods for the criminal justice professional including terminology, standard methodologies, and elementary statistics.

44-401 DRUGS AND THE CRIMINAL JUSTICE SYSTEM (3,0)3
This course is designed to cover the problem of drugs, drug abuse, the law and its application. Treatment of and alternatives to drug rehabilitation will be studied in addition to the classification, identification, distribution, and control of drugs.

44-406 SENIORS HONORS PROJECT (3,0)3

44-410 WOMEN IN CRIMINAL JUSTICE (3,0)3
The course is designed to identify and understand assumptions in theory and practice as they relate to women as criminals, victims and criminal justice practitioners. Biological, psychological and sociological theories and their implications will be analyzed. Women's reaction to both theory and practice will be examined.

44-421 ELITE DEVIANCE AND CRIME (3,0)3
This course examines the systematic violation of the laws and ethics of business and politics. The structure of power and privilege in relation to both political and economic deviance will be major topics. The impact of corporate crime and deviance on society and societal and legal reactions will be explored.

44-490 CRIMINAL JUSTICE RESEARCH SEMINAR (3,0)3
Specific practice in the definition, design and execution of a research project, and an analysis of the impact of contemporary criminal justice research on policy development. Prerequisite 44-390. Required of all criminal justice majors.

Directed Studies

Directed study courses are available only to majors in the administration of law and justice (criminal justice) and may be elected provided that 1) the material to be covered is not available in any course offered during the semester in which a directed study course is contemplated, 2) instructors are willing to undertake a directed study course, and 3) no more than 9 credits in the major field are earned in directed study courses.

44-491 DIRECTED STUDY IN CRIMINAL JUSTICE
Directed study offers the student the opportunity to engage in an independent study or research project under the supervision of a department member. The student, working closely with the instructor, will define and investigate a research problem in a special area of interest and present the results of his investigation in a significant paper. 3 cr.

44-496 PRACTICUM
Assigned field work under the supervision and with the permission of the professor assigned to the course. The purpose is to broaden the educational experience of the pre-service students in law enforcement, probation, and correctional agencies. This course is designed to provide a correlation of theoretical knowledge with practical experience in an area of particular interest to the student.

DEPARTMENT OF ENGLISH

William Hersey, Chairperson

Professors: William Aiken, William C. Burto, *Emeritus,* Robert Foy, Clifford Lewis, Barbara Miliaras, Howard Moore, *Emeritus,* Gerard O'Connor, William Roberts, Robert Stein, Roger Wiehe, Joseph Zaitchik, Charles Ziavras

Associate Professors: Donald Berry, Robert DeYoung, Arthur Friedman, William Hersey, Marianne Knowlton, Mary Kramer, Martha McGowan, Judith Pastore, Francesca Tillona, Gardner Tillson

Assistant Professors: Sharon Cogdill, Andrea Corbett, William Coughlin, Arthur Dabilis, Robert Griffin, David Landman, John McCaffrey, Melissa Pennell, Charles Ryan, Joseph Ryan, Anthony Turrisi

The Department of English offers a major in English leading to the Bachelor of Arts Degree. The Department also offers a general minor in English and specialized minors in English literature, American literature, drama, and writing.

The English Major (30-45 credits)

The English Department offers two separate concentrations: one in literature, the other in writing. Both concentrations require an intermediate proficiency in a foreign language and also the following seven courses:

42-201 Great Books of Antiquity
42-291 History of English Literature I
42-292 History of English Literature II
42-294 History of American Literature I
42-295 History of American Literature II
42-307 History and Development of the English Language, or:
42-308 Analysis of Modern English
42-423 Shakespeare I, or:
42-424 Shakespeare II

Additionally, both concentrations require 15 departmental credits at the 300 level and limit 200-level department credits to 6.

The Literature Concentration

The literature concentration also requires two period courses, one course from two of the following three categories:

Medieval and Renaissance
Restoration and Neoclassical
Romantic and Victorian

The Writing Concentration

Instead of two literature period courses, the writing concentration requires:

42-227 Advanced Expository Writing
42-410 Editing and Publishing Techniques

Writing concentrators must also choose three courses from the following list:

42-202 Topics in Writing
42-300 Journalism
42-305 Reviewing the Arts
42-306 Professional Writing
42-309 Argumentation and Research Skills
42-390 Advanced Technical and Scientific Writing
42-391 Business Communication
42-402 Selected Issues in Writing

In addition, a practicum experience is strongly recommended for writing concentrators. Students must arrange for their practicum experience during the pre-registration period with the director of the writing concentration, Dr. William Roberts, or with the department chairperson.

Requirements for Minors

All English Department minors are open to students enrolled in every undergraduate college at the University.

American Literature

A minor in American literature consists of 18-24 credits selected in accordance with the following specifications. At least 6 credits of courses must be taken at the 300 level or above.

42-294 History of American Literature I
42-295 History of American Literature II
42-291 History of English Literature I; or
42-292 History of English Literature II
Electives in American Literature

Drama

A minor in drama consists of 18-24 credits selected in accordance with the following specifications. At least 6 credits of courses must be taken at the 300 level or above.

42-218 Comedy
42-219 Tragedy
42-423 Shakespeare I
42-424 Shakespeare II
Electives in drama
Electives in stagecraft or acting

English (General English Minor)

This minor consists of 18-24 credits of course work selected in accordance with the following specifications and including 6 credits of courses which are numbered 300 level or above.

42-291 History of English Literature I
42-292 History of English Literature II
42-423 Shakespeare I: or
42-424 Shakespeare II
One course in American literature
English electives

English Literature

18-24 credits of course work, including the following required courses. Also at least 6 credits must be taken at the 300 level or above.

42-291 History of English Literature I
42-292 History of English Literature II
42-423 Shakespeare I: or
42-242 Shakespeare II
Electives in English Literature

Writing Minor in English

The writing minor consists of 18-24 credits of course work selected in accordance with the following specifications.

1. To be eligible, students must receive a grade of "B" or better in Advanced Expository Writing. They must also successfully complete Analysis of Modern English.

2. In addition, students must complete at least two writing courses from the following list. One of these courses must be a course related to the student's major field of study or a Writing Workshop.

   42-202 Topics in Writing
   42-300 Journalism
   42-305 Reviewing the Arts
   42-306 Professional Writing
   42-309 Argumentation and Research Skills
   42-390 Advanced Technical and Scientific Writing
   42-391 Business Communication
   42-402 Selected Issues in Writing
   42-410 Editing and Publishing
   42-450 Writing Workshop

3. The remaining courses (6 to 12) credits may be selected from the English Department's general offerings.

English (Course Prefix: 42)

42-101 COLLEGE WRITING I*
An intensive review of grammar and usage, and an introduction to rhetorical technique, the art of writing. 3 cr.

42-102 COLLEGE WRITING II*
A continuation of 101, introducing students to the more advanced rhetorical modes and to the symbolic use of language. Prerequisite: 42-101 3 cr.

42-103 COLLEGE WRITING FOR INTERNATIONAL STUDENTS*
Equivalent to 42-101, for students who speak English as a second language. Credit for both 42-101 and 103 may not be granted. 3 cr.

42-104 COLLEGE WRITING II FOR INTERNATIONAL STUDENTS*
Equivalent to 42-102, for students who speak English as a second language. Credit for both 42-102 and 104 may not be granted. 3 cr.

42-201 GREAT BOOKS OF ANTIQUITY
Representative literary selections from the Bible, classical Greece and imperial Rome against their cultural and historical backgrounds. 3 cr.

42-202 GREAT BOOKS OF THE MODERN PERIOD
Representative literary selections from the period of the Enlightenment to the present. 3 cr.

42-203 TECHNOLOGY AND HUMAN VALUES I
Same as 59-203. 3 cr.

42-204 TECHNOLOGY AND HUMAN VALUES II
Same as 59-204. 3 cr.

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* Before enrolling in any advanced English course, students must complete 42-101 and 42-102 (or their equivalent 42-103 and 42-104) to fulfill the University requirement of 6 hours in composition. For English majors, 42-102 is co-requisite with 42-201.

42-205 HUMAN VALUES IN WESTERN CULTURE I
A close study of representative literary, philosophical, and religious texts from ancient times to the present, and relevant modern works in the behavioral and political sciences. In the first semester, the students explore and evaluate three perennial themes: the problem of evil, self and society, freedom and fate. 3 cr.

42-206 HUMAN VALUES IN WESTERN CULTURE II
A continuation of 42-205. May be taken independently. Themes to be explored include the pursuit of knowledge, the nature of humankind, the experience of love. 3 cr.

42-210 DRAMA
A study of selections from the classical through the contemporary periods. 3 cr

42-211 POETRY
A study of selections from the Renaissance through the contemporary periods. 3 cr.

42-212 THE SHORT STORY
A study of the development of the genre. 3 cr.

42-213 BIOGRAPHY
A study of selections from Plutarch to the present with emphasis on biography and autobiography as a source of ideas and values. 3 cr.

42-214 SATIRE
A study of selections from the classical through the contemporary periods, including satire in the media. 3 cr.

42-215 THE MODERN ESSAY
A study of the essay as the literature of ideas. Concentration on twentieth century writers with attention to early examples of the genre. 3 cr.

42-216 THE SHORT NOVEL
A study of the nineteenth and twentieth century short novel as a literary genre. 3 cr.

42-217 THE HORROR STORY
A study of the genre concentrating on major writers from Poe to the present. 3 cr.

42-218 COMEDY
A study of the theory and practice of comedy from the Greeks to the present. 3 cr.

42-219 TRAGEDY
A study of the theory and practice of tragedy from the Greeks to the present. 3 cr.

42-220 PERSONAL AND REFLECTIVE WRITING
The course will be organized around a workshop format to encourage both peer criticism and discussion of models from various texts. 3 cr.

42-221 LITERATURE FOR CHILDREN AND ADOLESCENTS
A study of literature intended for elementary and secondary school age readers. 3 cr.

42-222 ORAL COMMUNICATION
The course develops and applies the basic speaking skills adaptable to a variety of personal and professional contexts. Emphasis on selection, analysis, organization and presentation of speech materials. Practice skills include listening, interviewing, and the delivery and critique of extemporaneous speeches. 3 cr.

42-224 BUSINESS WRITING
A study of the theory and practice of letters, memoranda, and reports on specific business

and technical problems. Restricted to students enrolled in the College of Management Science. 3 cr.

42-225 TECHNICAL AND SCIENTIFIC WRITING

A study of the theory and practice of letters, memoranda, and reports on specific scientific and technical subject matter. Enrollment is limited to students who are required to take the course. With the permission of the instructor, other students in the College of Engineering and the College of Pure and Applied Sciences may be admitted when space permits. 3 cr.

42-227 ADVANCED EXPOSITORY WRITING

A review of the major modes of exposition with an emphasis on structure, audience, and style. The writing process is emphasized as students prepare one short paper each week. 3 cr.

42-230 ELEMENTS OF FILM

A study of the elements of film as revealed in selected film classics with emphasis on analysis and evaluation. 3 cr.

42-234 MODERN FICTION AND THE FUTURE

The study of English, American, and European novels which offer visions of the future based upon present political, social and scientific trends. 3 cr.

42-240 LITERATURE AND WOMEN

A survey of literary attitudes towards women, from the Judaic and Hellenic periods through the present day. 3 cr.

42-241 WOMEN IN FILM

A survey of the image of women in commercial film from the beginnings to the present with emphasis upon the films of the 1930's and 40's and the 1970's and 80's. In addition to class viewing, several commercial viewings will be scheduled. 3 cr.

42-242 THE HEROINE IN MODERN FICTION

A study of selected short stories and novels which deal sympathetically with the changing roles of women. 3 cr.

42-243 CONTEMPORARY WOMEN WRITERS

A study of recent work in the novel, short story, drama, and poetry by British and American women. 3 cr.

42-244 WOMEN IN THE MIDDLE AGES AND RENAISSANCE

A study of the major literary and historical women of the Middle Ages and Renaissance, their impact on their times, and their place in society. 3 cr.

42-245 LITERATURE ON TECHNOLOGY AND HUMAN VALUES

An examination of nineteenth and twentieth century British and American literature to understand what the impact of modern technology has been on the development of ethical values. 3 cr.

42-246 THE PICARESQUE HERO

A study of the picaresque hero depicted by such writers as Quevedo, Defoe, Grimmelshausen, Thackeray, Celine, Bellow, Waugh and Ellison, which gives attention to theories of comedy. 3 cr.

42-248 VALUES IN AMERICAN CULTURE

A study of various works of literature and popular culture that illustrate the continuity of American ideals, beliefs, and aspirations. 3 cr.

42-250 THE BIBLE AS LITERATURE
A literary and historical analysis of selected Old and New Testament books. 3 cr.

42-252 LITERATURE AND SCIENCE
A study of literary works from the classical to the contemporary periods that deal with science and its cultural implications; topics will include "the two cultures," the scientist as hero, and science fiction. 3 cr.

42-253 THE CULTURE OF AMERICAN SPORT
An examination of the history, literature, sociology, and aesthetics of sport and corollary issues and values, including racism, sexism, and violence. 3 cr.

42-257 THE FAMILY IN LITERATURE
A study of literary selections dealing with traditions of family life and social change. 3 cr.

42-259 PROTEST FICTION IN AMERICA
A study of American fiction concerned with the oppression of blacks, working people and the poor. 3 cr.

42-261 ACTING
A study of the theory and practice of acting including exercises in the elements and methods of acting and the preperation of a public performance. 3 cr.

42-262 ADVANCED ACTING
A continuation of 42-261, which is a prerequisite. 3 cr.

42-263 MODERN AMERICAN DRAMA
A study of such playwrights as O'Neil, Odets, Wilder, Williams, and Miller. 3 cr.

42-267 INTRODUCTION TO SHAKESPEARE
A study of selected histories, comedies, and tragedies. 3 cr.

42-269 TWENTIETH CENTURY BRITISH LITERATURE
The prose, poetry, and drama of England in this century. 3 cr.

42-270 CONTEMPORARY AMERICAN FICTION
A study of writers since World War II: Barth, Bellow, Malamud, Mailer, Vonnegut, and Pynchon among others. 3 cr.

42-271 MODERN BRITISH LITERATURE
A study of writers since 1875: Hardy, Lawrence, Woolf, Orwell, Waugh, Murdock, and others. 3 cr.

42-272 CONTINENTAL FICTION
A study of selected short stories, novellas, and novels by major continental writers of the nineteenth and twentieth centuries, including Flaubert, Gide, Camus, Sartre, Dostoevsky, Tolstoy, Zamyatin, and Pirandello. 3 cr.

42-274 LITERATURE OF THE BEAT MOVEMENT
A study of the Beat rebellion in the context of the 50's and 60's in America, including such writers as Burroughs, Corso, Ferlinghetti, Ginsberg and Kerouac. 3 cr.

42-275 MODERN IRISH LITERATURE
A study of Irish writing from 1890 to the present, with emphasis on the work of Yeats, Synge, O'Casey, O'Connor, and O'Faolain. 3 cr.

42-276 IRISH AMERICAN LITERATURE
The fiction, drama, poetry, and popular culture of the American Irish from immigration to the present. 3 cr.

42-291 HISTORY OF ENGLISH LITERATURE I
A study of the historical development of English literature from the beginnings to Milton. 3 cr.

42-292 HISTORY OF ENGLISH LITERATURE II
A study of the development of English literature from Dryden to the beginning of the twentieth century. 3 cr.

42-294 HISTORY OF AMERICAN LITERATURE I
A study of the historical development of American literature from the colonial period to the Civil War. 3 cr.

42-295 HISTORY OF AMERICAN LITERATURE II
A study of the historical development of American literature from the Civil War to World War I. 3 cr.

42-300 JOURNALISM
An introduction to the techniques of writing for the news media. 3 cr.

42-302 CREATIVE WRITING: FICTION
A study of the theory and practice of fiction; conducted as a workshop with close analysis of students' work. 3 cr.

42-303 CREATIVE WRITING: POETRY
Theory and practice of poetry; conducted as a workshop with close analysis of students' work. 3 cr.

42-304 CREATIVE WRITING: PLAYWRITING
A study of the theory and practice of playwriting; conducted as a workshop with close analysis of students' work. Instructor's permission required. 3 cr.

42-305 REVIEWING THE ARTS
A course in writing short, critical essays in a journalistic mode on the performing or visual arts. Special emphasis is given to theatre, movie, and television criticism. 3 cr.

42-306 PROFESSIONAL WRITING
An introduction to the principles and practical strategies of writing correspondence, instructions, reports, proposals, and other informative and persuasive documents used in business, industry, government, and the professions. 3 cr.

42-307 HISTORY AND DEVELOPMENT OF THE ENGLISH LANGUAGE
A study of the phonetic, lexical, syntactical, and semantic shifts in the English language from its beginning to the present. 3 cr.

42-308 ANALYSIS OF MODERN ENGLISH
A survey of applied linguistic, including structural, traditional and transformational grammars, and such related areas as sociolinguistics, dialectology, and basic semantics. 3 cr.

42-309 ARGUMENTATION AND RESEARCH SKILLS
A course in analyzing and writing arguments. Emphasis will be placed on the claim, support, and warrant approach to argumentation. Class time will also be devoted to research skills and bibliographic techniques. 3 cr.

42-311 THE SOUTH IN AMERICAN LITERATURE
A study of the writers, movements, and social culture of the South, including such representatives as Douglass, Hellman, Faulkner, Ransom, the Fugitives, Warren, King and Moody. 3 cr.

42-312 AMERICAN PURITIANISM AS A LITERARY INFLUENCE
A study of Puritian values as seen in selected colonial writings, and in confrontation with other values in nineteenth century literature. 3 cr.

42-313 REALISM AND NATURALISM IN AMERICAN FICTION
A study of realistic and naturalistic fiction from the end of the Civil War to the beginning of World War I. 3 cr.

42-317 BRITISH LITERATURE OF THE TWENTIETH CENTURY
A study of twentieth century British short stories, novels, poetry, and drama. 3 cr.

42-318 AMERICAN LITERATURE OF THE TWENTIETH CENTURY
A study of twentieth century American short-stories, novels, poetry and drama. 3 cr.

42-325 THE RISE OF THE NOVEL
A study of the British novel in the eighteenth century from Defoe through Austen. 3 cr.

42-326 THE NINETEENTH CENTURY BRITISH NOVEL
A study of the novel from Scott through Hardy. 3 cr.

42-330 THE TWENTIETH CENTURY BRITISH NOVEL
A study of the novel from Conrad through Greene. 3 cr.

42-331 AMERICAN NOVEL TO 1900
A study of the American novel from its colonial beginnings through the nineteenth century. 3 cr.

42-332 AMERICAN NOVEL OF THE TWENTIETH CENTURY
A study of the American novel from 1900 to the present. 3 cr.

42-345 FEMALE ENGLISH NOVELISTS
Selected novels by Austen, the Brontes, Eliot, Woolf, Bowen, and Drabble. 3 cr.

42-351 LITERATURE OF THE ENGLISH MIDDLE AGES
A study of the prose, poetry, and drama of England from 1200-1500, against their cultural and historical backgrounds. 3 cr.

42-352 LITERATURE OF THE SIXTEENTH CENTURY
A study of English prose and poetry of the sixteenth century. 3 cr.

42-353 LITERATURE OF THE SEVENTEENTH CENTURY
A study of English prose and poetry of the seventeenth century, excluding Milton. 3 cr.

42-354 LITERATURE OF THE EIGHTEENTH CENTURY
A study of English prose and poetry of the eighteenth century. 3 cr.

42-355 LITERATURE OF THE ROMANTIC PERIOD
A study of English poetry and prose of the Romantic Period: 1798-1832. 3 cr.

42-356 LITERATURE OF THE VICTORIAN PERIOD
A study of English poetry and prose of the Victorian Period: 1832-1901. 3 cr.

42-360 MEDIEVAL AND RENAISSANCE THEATRE
This course will examine some of the major medieval mystery cycles, morality plays, interludes, and other forms of popular and court theatre not including the dramas of Shakespeare, Marlowe, and Jonson. 3 cr.

42-361 RESTORATION COMEDY
A study of plays by Congreve, Etherege, Farquhar, Vanbrugh, and Wycherley and others, and their influence upon the later eighteenth century. "Laughing Comedies" of Goldsmith and Sheridan. 3 cr.

42-362 MODERN DRAMA
A study of selected continental, British and American plays of the late nineteenth century to the present. 3 cr.

42-363 ELIZABETHAN AND JACOBEAN DRAMA (exclusive of Shakespeare)
A study of the major dramatists of the Age of Shakespeare and immediately after: Marlowe, Dekker, Webster, Jonson, Beaumont and Fletcher, Massinger, Ford, and others. 3 cr.

42-370 MODERN POETRY
A study of the development of English and American poetry from 1900 through World War II. 3 cr.

42-374 CONTEMPORARY AMERICAN POETRY
A study of selected poets since World War II. 3 cr.

42-381 THE EXISTENTIAL HERO
A study of the development of the existential hero in selected works by Stendahl, Melville, Dostoevsky, Hemingway, Gide, Sartre, Camus, and Beckett. 3 cr.

42-388 UNDERGRADUATE SEMINAR ON THE TEACHING OF WRITING
Training in writing theory for direct application in peer tutoring. Discussion of theory supplemented by experiential exercises, class presentations, reading, and writing. Meets two hours each week: students tutor four hours each week. 3 cr.

42-390 ADVANCED TECHNICAL AND SCIENTIFIC WRITING
Theory and practice of writing on scientific and technical subject matter. For English majors and minors. 3 cr.

42-391 BUSINESS COMMUNICATION
Study of the special problems of writing in business. Assignments cover style, strategies for correspondence, presentation of complex information, and writing for sales. For English majors and minors. 3 cr.

Note: Courses numbered 400 and above are restricted to English majors only.

42-401 SELECTED AUTHORS
A study of the works of selected major authors; to be announced each semester. 3 cr.

42-402 TOPICS IN WRITING
Study of the issues and practice of the skills needed in an area of professional writing. Topics to be announced each semester. 3 cr.

42-410 EDITING AND PUBLISHING TECHNIQUES
Study and application of basic editorial techniques in the contexts of present-day publishing. 3 cr.

42-421 CHAUCER
A study of the major works of Chaucer. 3 cr.

42-423 SHAKESPEARE I
A study of selected histories, comedies, and tragedies. 3 cr.

42-424 SHAKESPEARE II
A study of selected histories, comedies, and tragedies not covered in 42-423. Readings from 423 and 424 to be announced each semester. 3 cr.

42-426 MILTON
A study of the major poems and of selected prose. 3 cr.

42-430 LITERARY CRITICISM
A study of the major statements about literature from Plato and Aristotle through contemporary critics. 3 cr.

42-431 CONTEMPORARY LINGUISTIC THEORY
Recent developments in linguistic theory. 3 cr.

42-450 WRITING WORKSHOP
A substantial writing project is developed through a collaborative effort from the student's major department and the English department. Permission of chairperson required. 3 cr.

Directed Studies

The department offers directed studies for English majors only. Students may enroll in these courses provided that 1) they have at least a 3.00 average for English courses, 2) the material to be covered is not available in any English course offered during the semester in which directed studies is contemplated, 3) instructors are willing to undertake a directed studies, and 4) arrangements for directed studies are made through the chairperson. A maximum of 6 credits in the major field may be acquired through registration for directed studies courses.

42-491 DIRECTED STUDY IN LITERATURE
The student develops a course of directed reading in literature, defines a problem for individual research, and prepares a paper or papers. 3 cr.

42-492 DIRECTED STUDY IN LANGUAGE ANALYSIS
The student develops a course of directed readings in linguistics, semantics, or stylistics, and defines a problem for individual research.

42-493 DIRECTED STUDY IN CREATIVE WRITING
The student develops a series of projects in creative writing and writes poetry, fiction, or drama. 3 cr.

42-496 PRACTICUM
An off-campus writing experience for writing concentrators. The intent of the practicum experience is to provide students with the opportunity to apply their writing skills in actual business, technical, and professional situations. 3 cr.

DEPARTMENT OF HISTORY

Charles Carroll, Chairperson

Professors: Christos Bentas, Mary Blewett, Charles Carroll, Patricia Goler, Joseph Lipchitz, Donald Mattheisen, Arthur Miller, Francis Walsh

Associate Professors: Harald Bakken, Dean Bergeron, Peter Blewett, Richard Derry, Jonathan Liebowitz, George Luter, John Shea

History Major

A major in history provides students with a broad introduction to civilizations of the past and present, including those of antiquity, Europe, America, and the Third World, plus a thorough grounding in the historical process. Through a broad exposure to the complexities shaping the forces of civilization, the history major gains a special perspective by which he or she can view human thought and action while also developing his or her ability to determine bias, to make valid generalizations, to draw valid inferences, and to perceive the significance of fact within the framework of interpretations. The history major provides a meaningful background for those students who desire to enter government service, politics, law, teaching, and business.

The major in history consists of 36-45 credits (with at least 15 credits at the 300 course level or above) and must include the following:

43-105 Western Civilization to 1715, and
43-106 The Modern World
43-108 Freshman Seminar
plus
43-370 Introduction to Historical Method
43-432 Research Seminar in History

The Department also requires one course in the third world*, two courses on or above the 200 level in both European and American History, and two additional courses in either European or American history. The remaining courses for the major may be selected from history course offerings.

Students transferring to the college who wish to major in history must make individual arrangements with the chairperson of the department regarding satisfaction of major requirements.

The department offers two additional specialized concentrations within the major which are designed to take advantage of the strengths of the faculty and the immediate locality. They are: 1) the American Industrial Revolution; and 2) Modern European Social and Economic History. Students interested in these courses of study should contact the chairperson for more information.

Minor Requirements

American History

A minor in American history consists of 18-24 credits. At least 6 credits must be taken in courses at the 300 level or above. Course work is selected in consultation with the faculty advisor.

European History

A minor in European history consists of 18-24 credits. At least 6 credits must be taken in courses at the 300 level or above. Course work is selected in consultation with the faculty advisor.

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* Third world courses: all courses dealing with Asian, African, or Latin American history, plus the following courses: 43-228: The American Indian; 43-366: Colonialism and the Third World.

History (General History Minor)

A minor in history consists of 18-24 credits. At least 6 credits must be taken in courses at the 300 level or above. Course work is selected in consultation with the faculty advisor.

Interdisciplinary Minors

Students should refer to the listing of interdisciplinary minors in the liberal arts which will be found at the end of the College of Liberal Arts section of this bulletin.

History (Course Prefix: 43)

43-101 CLASSICAL CIVILIZATION
The political, social and cultural history of the Graeco-Roman world from the age of heroes to the fall of the Roman empire. (Not open to history concentrators.) Bentas. 3 cr.

43-105 WESTERN CIVILIZATION TO 1715
Traces the major forces in the development of European history from the beginning of Greek civilization to 1715. 3 cr.

43-106 THE MODERN WORLD
Examines the major forces in the development of modern European history in a global context from the French Revolution to the present. 3 cr.

43-108 FRESHMAN SEMINAR: HISTORICAL CLASSICS
An introductory course required of all new students in the department, whether freshmen or transfers. Major works in the discipline will be discussed and analyzed over the course of the semester with the object of discovering how historians work, what questions they ask, and what the art of history is. (Majors only). Members of the department.

43-111 UNITED STATES HISTORY TO 1877
Traces the development of American history and institutions from colonization to the end of reconstruction. (Not open to history concentrators.) 3 cr.

43-112 UNITED STATES HISTORY SINCE 1877
Examines significant developments in American history from the end of the reconstruction period to the present. (Not open to history concentrators.) 3 cr.

43-203 TECHNOLOGY AND HUMAN VALUES I
See 59-203. 3 cr.

43-204 THE ORIENT SINCE 1500
This survey concentrates on China, Japan and India as the three dominant contemporary Asian civilizations. The course begins with an analysis of them as traditional societies and then traces their history in response to the impact of the aggressive modernizing states of Western Europe and America. P. Blewett. 3 cr.

43-205 PRE-COLUMBIAN AMERICA
A study of the peoples and civilization of the Americas from their origins to the first contact with Europeans. Luter. 3 cr.

43-206 LATIN AMERICAN CIVILIZATION
An introduction to Latin American history through the study of selected topics from the age of discovery and conquest to the present. Luter. 3 cr.

43-207 AMERICAN ENVIRONMENTAL HISTORY
Attitudes, policies, and behavior of Americans and their government toward the environ-

ment. Special attention to current issues evolving out of our past attitudes and policies. (This course is cross-listed as 46-207.) Bergeron. 3 cr.

43-215 COMPUTERS IN SOCIETY

The course explores the history of computers and their interaction with contemporary society. It begins by looking at the nature of computers and their development from Charles Babbage to the present. Then follows a series of specific examples of the possibilities and problems that arise from the use of computers in different areas of contemporary life. The class looks at computers in education, the military, and business, concluding with issues of freedom vs. control of the individual. The course encourages students from many disciplines to examine critically the place of this new machine in our lives. (This course is interdisciplinary and is cross referenced as 59-215). Liebowitz. 3 cr.

43-217 RENAISSANCE AND REFORMATION

The history of Europe in the time of transition between the late Middle Ages and the Early Modern Period. Two principle topics will be the intensification of cultural change which began in Italy around 1300 and spread slowly northward, and the disruption of the unity of the Western Christian Church. P. Blewett. 3 cr.

43-222 EUROPE IN THE TWENTIETH CENTURY

An examination of selected topics in European history from 1914 to the present: World War I, the Versailles conference, unrest and the collapse of collective security, the rise of Communism, Fascism, Nazism, World War II and postwar developments. Shea, Liebowitz. 3 cr.

43-225 ANCIENT GREEK HISTORY AND CIVILIZATION

A study of Greek history, institutions and culture from Minoan times through the Hellenistic period. Bentas. 3 cr.

43-226 ROMAN HISTORY AND CIVLIZATION

An analysis of the history, institutions and culture of the Roman Republic and Empire from earliest times to 330 A.D. Bentas. 3 cr.

43-227 THE EARLY MIDDLE AGES

A survey of the Latin west during the formative period from the Roman Empire to the creation of the first European civilization. Derry. 3 cr.

43-228 THE AMERICAN INDIAN

A study of native Americans from their first contact with Europeans to the present, with special emphasis on North American Indians and their relationship with the United States government. Luter. 3 cr.

43-230 COLONIAL AMERICA: HISTORY AND CULTURE

Emphasis is on the seventeenth- and early eighteenth-century colonies in British North America and the Carribbean. Topics include: the social, intellectual, and economic development of Virginia and the Puritian colonies, race relations and the origins of slavery, the development of the trans-Atlantic economy, technology and adaptation to the new environment. Carroll. 3 cr.

43-232 THE AMERICAN REVOLUTION

Eighteenth-century America with emphasis on Anglo-American cultural developments, religious change, British colonial policy, revolutionary ideology, and the War for Independence. Carroll. 3 cr.

43-235 CIVIL WAR AND RECONSTRUCTION

Examines the Civil War and Reconstruction in terms not only of events but also of the traditional and revisionist interpretations. Bergeron 3 cr.

43-239 AMERICAN ECONOMIC HISTORY

A study of the growth and development of the American economy from its European origins to the present. Lipchitz. 3 cr.

43-243 AMERICAN URBAN HISTORY I

An examination of the process of urbanization in America. Topics covered include the origin and development of the American city, ethnic conflict, the political machine, police and transportation. Walsh. 3 cr.

43-244 AMERICAN URBAN HISTORY II

A continuation of 43-243. Topics include poverty, housing, health delivery, suburbanization, and city planning. Walsh. 3 cr.

43-248 HISTORY OF JAPAN SINCE 1600

A study of the traditional Japanese institutions and the transformation of Japan into a modern state after 1868; the Tokugawa shogunate, Meiji restoration, Russo-Japanese War, world power status, militarism, World War II, and present day Japan. Shea. 3 cr.

43-253 EUROPEAN SOCIAL AND ECONOMIC HISTORY SINCE THE INDUSTRIAL REVOLUTION

The causes of the industrial revolution and the process of industrialization. Life in the urban, industrial world. New ideologies, new types of social organization, European economic integration. Liebowitz. 3 cr.

43-254 FRANCE SINCE 1814

A history of modern France in a broad European setting from the Bourbon restoration through the Fifth Republic. The course examines the interaction of social, economic, political and diplomatic trends, with particular attention to the struggle between the Right and the Left. Shea. 3 cr.

43-255 HISTORY OF GERMANY TO 1871

Political and cultural development of the German nation from the Reformation to the creation of a unified nation-state in the nineteenth century. Topics include the Renaissance and the Reformation, the Thirty Years War, the rise of Brandenburg—Prussia, German absolutism in the era of Frederick the Great, the German Enlightenment, the upheaval of the French Revolutionary era, and finally the growth of German nationalism. Mattheisen. 3 cr.

43-258 HISTORY OF RUSSIA TO 1796

The growth of the Russian state: Varangian origins, the Kievan state, conversion to Christianity, Mongol domination, the rise of Muscovy, Europeanization and expansion under Peter the Great and Catherine the Great. Shea. 3 cr.

43-259 HISTORY OF RUSSIA IN THE 19th-20th CENTURIES

Selected topics in modern Russian history: political and social reforms of the nineteenth century, international policies in Europe and Asia, the 1917 revolutions, development of the new regime under Lenin, Stalinist policies, World War II and Russian expansion. Shea. 3 cr.

43-261 GREEK AND ROMAN HISTORIANS

Extensive reading in English translation of important Greek and Roman historians. Works of Herodotus, Thucydides, Xenophon, Livy, Tacitus and Procopius. Bentas. 3 cr.

43-266 HISTORY OF AMERICAN POPULAR CULTURE
An investigation of the social content and institutional character of mass culture in America since 1850. Walsh 3 cr.

43-268 HISTORY OF THE FAMILY AND CHILDHOOD IN THE UNITED STATES
An analysis of the status of children, the role of the family, and effect of other institutions on children and family throughout American history. Includes historical study of an individual family. Bakken. 3 cr.

43-270 WOMEN IN AMERICAN HISTORY
A study of women as a social group in American history. M. Blewett. 3 cr.

43-274 THE FAMILY IN WESTERN SOCIETY
An analysis of changes in the role of the family in Europe and America. Relations between husbands and wives, parents and children, the family and society as a whole will be covered. Special attention will be given to the impact of modernization and industrialization on the family. Liebowitz. 3 cr.

43-277 ETHNIC GROUPS IN AMERICAN LIFE
An examination of the importance of ethnic groups in American history. The course will treat several major ethnic groups and their assimilation or non-assimilation into American life. Field work and research on ethnic groups in the Merrimack Valley. Bakken. 3 cr.

43-284 SCIENCE AND THE MODERN WORLD
A survey of scientific and technological thought from the Babylonians and Egyptians to the present. Emphasis is on the interplay among science, technology, and society, as well as the organization of science as a discipline. Miller. 3 cr.

43-302 THE GILDED AGE: UNITED STATES HISTORY, 1877-1900
An examination of the social, cultural, and political changes involved in the development of the United States as a modern industrial nation and its rise to status as a world power. M. Blewett. 3 cr.

43-303 THE 20s AND THE 30s
An examination of the emergence of the corporate and governmental institutions of modern America set in two turbulent decades of cultural and political ferment that involved both booming prosperity and the economic collapse of the Great Depression. M. Blewett. 3 cr.

43-304 RECENT U.S. HISTORY, 1940 TO THE PRESENT
The involvement of the U.S. in World War II marked a major turning point in American history. It ushered in twenty years of Cold War tensions, the militarization of society and participation in foreign alliances and limited wars. Anti-communist conservatives, militant Blacks and a New Left polarized politics and produced a contemporary crisis of confidence in American society. M. Blewett. 3 cr.

43-305 AMERICAN INTELLECTUAL HISTORY TO 1890
Selected topics in intellectual history from colonial times to the Civil War. Examines the major intellectual currents and the interaction between ideas and social structure. Topics include Puritianism, political philosophy, the pursuit of an American style, slavery and the sectional conflict, trancendentalism and social reform, and Social Darwinism. Bakken. 3 cr.

43-306 AMERICAN INTELLECTUAL HISTORY SINCE 1890
Selected topics in intellectual history, concentrating on the twentieth century thinkers. Topics include pragmatism and its critics, 20th century political thought, critiques of

American values, Black social thought. Other topics to be selected by students. Prerequisite: 43-305 or permission of the instructor. Bakken. 3 cr.

43-307 WORK AND SOCIETY

A survey of labor history from the colonial period to the present, focusing on the interrelationship between culture and work in American society and on the dynamics of technical and economic changes on the organization of work processes. M. Blewett. 3 cr.

43-308 HISTORY OF CRIME, CONFLICT, AND CONTROL IN THE UNITED STATES

An analysis of the causes and development of attempts to control crime, ethnic conflict, radical protest movements, urban disorders, and attitude and role conflicts. Walsh. 3 cr.

43-312 MODERN LATIN AMERICA

An analysis of significant trends and problems of Latin America, with emphasis on the economic, political, and social conditions which stimulate or deter progress. Luter. 3 cr.

43-314 SOCIETY AND CULTURE IN THE EARLY MIDDLE AGES

This course will explore the political, social, and cultural transformation which took place in Europe during the five centuries following the collapse of the Western Roman Empire. Drawing from historical, literary, linguistic and artistic sources, the classes and lectures will focus on the classical, Christian, Germanic, and Celtic contributions to the new society and culture that was being created in Europe at this time. Special attention and the cultivation of letters. A major aim of the course is to make the student aware of how this formulative period of the eary Middle Ages can help us understand the full achievements of medieval society and culture at its zenith and, ultimately, the European civilization to which it gave birth. (This course is interdisciplinary and is cross referenced as 59-314). Aste, Derry. 3 cr.

43-315 NEW ENGLAND HISTORY

Study of New England as a distinct and unique section of the United States. Particular emphasis will be placed on the political history of New England and the contributions of this region to national development. Bergeron. 3 cr.

43-316 HISTORY OF LOWELL

The history of industry, politics and culture of the city of Lowell. 3 cr.

43-317 THE AMERICAN FRONTIER

Readings and discussion of the history of the American frontier and the place of the frontier in American society and thought. Bergeron. 3 cr.

43-320 MEDIEVAL INSTITUTIONS

An overview of selected political, social, and cultural forms in medieval society. The emphasis is on origins, growth and change, and the interaction of institutions. Topics will vary from year to year. Derry. 3 cr.

43-324 TECHNOLOGY AND AMERICAN CULTURE

An interdisciplinary study of the interrelationships among technological, economic, social, and cultural forces in America from 1775 to 1917. Topics include: the nature of economic growth, changes in the concept and organization of work, abstract and three-dimensional thinking, the nature of invention, the codification and diffusion of technical practices, the development of engineering as a profession, and the emergence of scientific technology. Special emphasis will be given to developments in water and steam power, textiles, iron and steel, electric communications and power, petroleum, and the internal combustion engine. Carroll. 3 cr.

43-326 CHRISTIANITY AND ROME

This course analyzes the late stages of the civilization of antiquity. The center of interest is the interaction of the new world-religion of Christianity with the mature Roman Empire, a cultural and political conflict which irrevocably changed a world. P. Blewett. 3 cr.

43-328 MEDIEVAL BIOGRAPHY

Through the reading of contemporary biographical and autobiographical works, as well as selected narrative accounts, the course will examine questions about historical attitudes, source criticism and interpretation and the writing of history. Derry. 3 cr.

43-335 QUANTITATIVE METHODS IN HISTORY AND POLITICAL SCIENCE

The application of statistical methods to problems in history and political science. Students will undertake a series of projects using the computer. The course is open to students from all majors. No previous experience is assumed. Liebowitz. 3 cr.

43-336 RADICALISM IN AMERICAN HISTORY

A biographical approach to the influence of radicalism on American history with emphasis on significant and representative personalities and their contributions. Bergeron. 3 cr.

43-337 HISTORY OF GERMANY SINCE 1871

Examines the meteoric rise and fall of modern Germany as a world power in its various manifestations as the German Empire, the Weimar Republic and the Nazi state. Some attention will also be given to the present-day republics of East and West Germany and to the continued influence of the "German Question" in world affairs. Mattheisen. 3 cr.

43-340 FOUNDATIONS OF ANGLO-AMERICAN LAW

A survey of the evolution of the English constitutional and legal system to 1800 with attention to the relevant political and social background. Special emphasis on the development of the Common Law, the criminal law system and the "unwritten constitution" from the Middle Ages to the beginnings of American colonial settlement. P. Blewett, Derry. 3 cr.

43-342 THE SECOND WORLD WAR

A general survey of the war, together with a closer examination of selected topics. Mattheisen. 3 cr.

43-345 MODERN EUROPEAN IMPERIALISM

Motives, methods and results of imperialism in the nineteenth and twentieth centuries: the partition of Africa and penetration of Asia as contrasting phases in the expansion of Europe. Shea. 3 cr.

43-352 ENGLAND IN THE MIDDLE AGES

The history of the English people and nation from the Roman conquest to the end of the fourteenth century, with special emphasis on the development of political and social institutions. Derry. 3 cr.

43-353 TUDOR ENGLAND

An intensive study of the social, economic, and constitutional structure of England in the 16th century, which, however, begins with a review of the problems of the period 1399-1485. P. Blewett. 3 cr.

43-354 STUART AND AUGUSTAN ENGLAND

A sequel to 43-353 (which is not a prerequisite), this course deals with the great revolution of the 17th century and its aftermath, emerging political stability, down to 1760. P. Blewett. 3 cr.

43-358 PROBLEMS OF MODERN IRELAND

Study and discussion of problems of twentieth-century Ireland set in their historical perspective. Lipchitz. 3 cr.

43-360 BYZANTINE HISTORY AND CIVILIZATION

A study of the important political, social and cultural changes in the East Roman Empire from the founding of Constantinople to the fall of the Empire in 1453, with the emphasis on the role of Byzantium as the custodian of the classical past. Bentas. 3 cr.

43-362 THE FRENCH REVOLUTION AND NAPOLEON

A close analysis of French society from 1600-1815 which attempts to understand the cause of the French Revolution and its aftermath. P. Blewett. 3 cr.

43-364 HISTORY OF SOCIALISM

The growth of the socialist movement from the utopian socialist thinkers of the early 19th century through the socialist, anarchist, and communist mass-movements of the 20th century. Mattheisen. 3 cr.

43-368 HISTORY OF THE MIDDLE EAST

An introduction to Islam and the history of the Middle East from Muhammad to the present. The course will focus on Islamic values as they come into contact with and impact upon our own culture and value system. Bergeron. 3 cr.

43-369 THE CONTEMPORARY MIDDLE EAST

An appreciation of Middle Eastern attitudes and values will be utilized in developing insight into the cultural tensions that exist between the Middle East and the western world. Political, financial and foreign policy problems will be emphasized with attention given to their relationship both to the United States business community and to the international business community. (This course is cross-listed as 46-369.) Bergeron. 3 cr.

43-370 INTRODUCTION TO HISTORICAL METHOD

An introduction for the undergraduate student to the nature and principles of history. The course takes up methodology, historiography, research methods, bibliography and the technical and stylistic problems involved in the presentation of research in scholarly form. Required of all history majors in sophomore year. Non-majors are admitted with permission of the instructor. Department faculty. 3 cr.

43-380 CONTEMPORARY AMERICAN FOREIGN POLICY

A study of the processes of American foreign policy in the contemporary world. The case study method will be used to illustrate problems of strategy and tactics in such areas as Europe, Latin America, Africa, and the Near and Far East. (This course is cross-listed as 46-380). Bergeron. 3 cr.

43-387 HUMOR AND SATIRE IN AMERICAN SOCIAL AND POLITICAL THOUGHT

Analyzes the role of humor and satire in American political and social thought; fiction, editorial humor, editorial and social cartoons, film, drama, popular entertainment, oral tradition. Conducted as a seminar. Major paper required. Bakken. 3 cr.

RESEARCH SEMINAR IN HISTORY

An original investigation in primary sources, culminating in the writing of a major paper based on systematic research and methodological techniques. Weekly meetings and reports. Prerequisites: 43-370 and permission of instructor. Required for all history majors. 3 cr.

Directed Studies

Directed Study courses are available only to history majors and may be selected provided that (1) the material to be covered is not available in any course to be offered in the semester in which the directed study is to be taken, (2) instructors are willing to undertake a directed study course, and (3) no more than 9 credits in the major field are earned in directed study courses.

43-420 20TH CENTURY REGIONAL AND INTERNATIONAL ORGANIZATIONS

Students will take part in a simulation of the proceedings of a regional or international organization, e.g., U.N., O.A.S., O.A.U., or the Arab League. They will study all aspects of the selected institution, but concentrate on key economic, social and security issues discussed in the body's debates. The aim of the course is to give students a clearer understanding of the forces and constraints which shape the foreign policies of individual states. Cross listed as 46-396. Bergeron. 3 cr.

43-491 DIRECTED STUDY IN HISTORY

Directed study offers the student the opportunity to engage in an independent study or research project under the supervision of a department member. Working closely with the instructor, the student will define and investigate a research problem in an area of special interest and present the results of his investigation in a significant paper. Juniors and seniors. Prerequisite: permission of instructor and chairperson. 3 cr.

43-485 ADVANCED TUTORIAL IN HISTORY

A program of directed study in which the student through regular consultation with the instructor develops an evaluative and critical essay. The purpose is to sharpen and refine techniques for scholarly research in the student's major discipline. Prerequisite: demonstrated proficiency in an area selected for directed study and permission of instructor and chairperson. 3 cr.

Practicum

43-496 PRACTICUM EXPERIENCE

A program of campus and off-campus experiences for history majors only. Specific requirements will vary, depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural or artistic area and for applying techniques of problem solving and/or skills which are appropriate to the student's major discipline. May be repeated to a maximum of 9 credits. Students will be graded "satisfactory" or "unsatisfactory". The practicum experience may not be substituted for a required course in the major. Prerequisite: permission of department chairperson. 3 cr.

DEPARTMENT OF LANGUAGES

Chairperson, Mario Aste

Professors: Mario Aste, Joseph Garreau

Associate Professors: Robert Bousquet, Heli Hernandez, Herlinda Saitz, John Staulo

Assistant Professors: Robert Whelan

The Department of Languages offers majors in French, Modern Languages, and Spanish leading to the Bachelor of Arts degree. Also offered are minors in French, German Studies, Greek, Italian Studies, Spanish, and (in cooperation with other departments) Classical Civilization and Latin American Studies.

Major Requirements

French Major

The French major provides a broad liberal arts education for students interested in developing a proficiency in the French language, a general knowledge of the cultural and literary heritage of French civilization and a basic insight into the function of verbal symbols in the process of human thought. This concentration provides students with sufficient preparation for a career in language teaching or bilingual education or for business or social-service careers requiring a command of the French language. A student may combine the French concentration with other supportive studies, thus tailoring an undergraduate program to meet his individual career objectives.

A major in French consists of 30-45 credits (with at least 15 credits at the 300 course level or above) and normally will include a combination of 18 credits in language, 12 in literature courses and 3 credits in culture courses.

50-221 Reading and Conversing in French I	3
50-222 Reading and Conversing in French II	3
50-246 Advanced French Conversation	3
50-310 French Speaking World	3
50-348 Advanced French Composition	3

Additional course work beyond the prescribed courses may be elected from the French offerings of the department to a maximum of 45 credits. Students who transfer to the college and who wish to major in French must make individual arrangements with the chairperson regarding satisfaction of major and collateral course requirements.

Modern Languages Major

The major in modern languages provides varied options for students who are interested in languages, not only from the viewpoint of a possible marketable skill, but also as a means of communication with people who speak a language which is different from their own.

A student may combine the modern language concentration with other supporting studies, thus tailoring an undergraduate program to meet his individual career objectives.

The modern language major consists of 36-45 credits above the 100 course level (with at least 15 credits at the 300 course level or above) and includes the following options:

Option I (French and Spanish)
Option II (French or Spanish) plus another language (Italian or German)

Typically, the student earns 24 credits in one language and 12 credits in the other. He or she may also elect a program with 18 credits in each language.

Students who transfer to the college and who wish to major in modern languages must make individual arrangements with the chairperson regarding satisfaction of major requirements.

Spanish Major

A major in Spanish provides a broad liberal arts education for students who are interested in developing a proficiency in the Spanish language, a broad knowledge of the cultural and literary heritage of Spanish and Latin American civilization, and a basic insight into the function of verbal symbols in the process of human thought. This major provides students with sufficient preparation for a career in language teaching and bilingual education and for business and social service careers requiring a command of the Spanish language. A student may combine the Spanish concentration with other supporting studies and may tailor his undergraduate program to meet his individual career objectives.

The major in Spanish consists of 36-45 credits (with at least 15 credits at the 300 level or above) and normally will include 18 credits in language courses, 15 credits in literature courses, and 3 credits in cultural courses.

54-222 Reading and Conversing in Spanish II
54-245 Advanced Spanish Conversation
54-347 Advanced Spanish Composition
54-350 Introduction to Literary Analysis

Additional course work beyond the prescribed courses may be elected from the Spanish offerings of the department to a maximum of 45 credits.

Students transferring to the College of Liberal Arts who wish to major in Spanish must make individual arrangements with the department chairperson regarding satisfaction of major and collateral course requirements.

Minor Requirements

French

A minor area of study consists of 18-24 credits, with at least 6 credits at the 300 or 400 levels. Beginning courses in French at the 100 level may not be credited to the French minor.

German Studies

The interdisciplinary minor in German Studies consists of 18-24 credits of course work. Six credits at the 200 level or above are required for the German language component. Additional courses to complete the required credits may be selected from the following list, or other courses currently listed in the catalogue.

43-217 Renaissance and Reformation
43-222 Europe in the 20th Century
43-255 History of Germany to 1871
43-337 History of Germany Since 1871
58-323 Northern Renaissance Art
59-320 Northern Baroque Culture

At least six credits must be taken in course work at the 300 level or above. Beginning courses in German at the 100 level may not be credited to the German Studies minor.

The list of approved courses may change from time to time depending on the offerings of the several departments involved; students should check with the chairperson of the language department to see which courses are currently approved.

Greek

A minor area of studies in Greek consists of 18 semester credits of course work and must include the following 53-101,102/Beginning Greek I,II, 53-301,302/Greek Classics, and 53-303,304/Selected Greek Authors. Unlike other modern languages, Greek has enjoyed a continuous tradition since antiquity and no break, such as that between Latin and the Romance languages, separates the language of ancients from the moderns. Educated Greek speakers have always had present in their minds the whole of the language up to their own time. Hence courses for the Greek minor include literature from all periods—from Homer and Plato to Kazantzakis.

Italian Studies

The interdisciplinary minor in Italian Studies consists of 18-24 credits of course work. Six credits at the 200 level or above are required for the Italian language component. Additional courses to complete the required credits may be selected from the following list, or other courses listed in the catalogue.

43-313	Renaissance and Reformation
43-277	Ethnic Groups in American Life
52-371	Dante's Divine Comedy
52-373	Italian Humanism
52-376	Pirandello: Theatre and Influence
52-378	Italian Culture Through Cinema and Literature
58-321	Italian Renaissance Art
58-322	Baroque Art in Italy

At least six credits must be taken in course work at the 300 level or above.

Beginning Italian courses at the 100 level may not be credited to the Italian minor.

The list of approved courses may change from time to time depending on the offerings of the several departments involved; students should check with the chairperson of the language department to see which courses are currently approved.

Spanish

A minor in Spanish consists of 18-24 credits with at least 6 credits at the 300 or 400 levels. Beginning courses in Spanish at the 100 level may not be credited to the Spanish minor. Students who are interested in the application of Spanish to the health professions should take 54-313; Fieldwork in the Spanish Community.

French (Course Prefix: 50)

50-101 BEGINNING FRENCH I*
Development of fundamental skills in oral expression, aural comprehension, reading and writing. Tapes available for laboratory use. Students who have completed more than one year of French at the secondary level are ineligible for this course. 3 cr.

50-102 BEGINNING FRENCH II*
A continuation of 50-101, which is a prerequisite. 3 cr.

* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

50-114 FRENCH FOR BUSINESS AND INTERNATIONAL MANAGEMENT II
A continuation of 50-101 with a reading emphasis, presenting to Business and Management sciences concentrators and others, by means of a cultural comparison between the French and American peoples, the terminology and practices of the Francophone business world particularly in the domains of Accounting, Banking, management and legal organization. 3 cr.

50-211 INTERMEDIATE CONVERSATIONAL FRENCH I*
Review of basic grammatical structures and idiomatic patterns with emphasis upon increased proficiency in oral expression and aural comprehension. This course in intended for students who have completed two years of high school French, preferably during their junior and senior years, for students who have completed 50-102, and/or for students who are unqualified for the 221-222 sequence. 3 cr.

50-212 INTERMEDIATE CONVERSATIONAL FRENCH II*
A continuation of 50-211, which is a prerequisite, with emphasis upon continued comprehension and conversational skills. 3 cr.

50-221 READING AND CONVERSING IN FRENCH I
The emphasis of this course is upon development and conversational skills, selected contemporary works provide the basis for developing conversational comprehension and composition skills. This course is intended for students with a solid foundation in the French language which has been gained from at least three years of high school study immediately prior to admission to the University. 3 cr.

50-222 READING AND CONVERSING IN FRENCH II
A continuation of 50-221, which is a prerequisite, with emphasis upon continued development of reading and conversational skills. 3 cr.

50-244 ADVANCED FRENCH GRAMMAR AND SYNTAX
A systematic study of grammatical and syntactical structures. Review of more advanced problems. 3 cr.

50-246 ADVANCED FRENCH CONVERSATION
Advanced oral practice in rapid and idiomatic speech. Topics of contemporary significance will be selected from contemporary prose. 3 cr.

50-301 SURVEY OF FRENCH LITERATURE I
A survey of French Literature based on the history and civilization of France from the Middle Ages to 1800. 3 cr.

50-302 SURVEY OF FRENCH LITERATURE II
A survey of French Literature based on the history and civilation of France from 1800 to the present. 3 cr.

50-310 THE FRENCH-SPEAKING WORLD
This course is designed for prospective majors and minors in French, as well as for those who have completed four years of high school or two years of college French. The program will examine similarities and differences in the ethos of nations of the French-speaking world and in the life-styles of the individuals and groups that make them up. Conducted in French. Garreau. 3 cr.

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* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

50-320 SPECIAL TOPICS IN FRENCH STUDIES

A limited topic of special interest in culture, civilization, or literature. May be taught in English or in French. Course content and approach will vary, depending on instructor. The department will post and distribute detailed course descriptions each semester, and students are urged to use this information in making their selections. 3 cr.

50-348 ADVANCED FRENCH COMPOSITION

Designed to impart proficiency in written French through regular exercises in free composition; analysis of literary texts. 3 cr.

50-372 APPLIED LINGUISTICS

Linguistic analysis of French phonology, morphology, and syntax and a comparison of the structures of French and English. Required for prespective teachers of French in the elementary and secondary schools. Bousquet. 3 cr.

50-401 SELECTED AUTHORS

An intensive study of works by several French authors. 3 cr.

50-432 THE NOUVEAU ROMAN

An examination of the techniques and procedures of French literature of the 50's and 60's with particular reference to Beckett, Butor, Robbe-Grillet, Sarraute, and Simon. Conducted in French. Prerequisite: permission of instructor. Bousquet. 3 cr.

50-442 THEATRE AND ANTI-THEATRE

The 20th century French theatre considered as an experimentation in new dramatic forms and as a metaphorical expression of a new vision of life. Plays from major writers (Claudel, Giraudoux, Anouilh, Sartre, Camus, Beckett, Genet, and Ionesco) will be analyzed. Conducted in French. Prerequisite: permission of instructor. 3 cr.

50-454 TECHNIQUES OF LITERARY ANALYSIS

Thematic and linguistic analysis of major French prose and poetry of the 19th and 20th centuries. Prerequisite: French concentrators with junior or senior status and others with permission of instructor. Conducted in French. 3 cr.

50-456 FRENCH TRANSLATION SEMINAR

A study of the theory and practice of translation, aimed and developing translation skills. Material used is taken from literary works, as well as newspapers and magazines. This course is intended for students with good command of the language. Open to French concentrators and others by permission of instructor. 3 cr.

Directed Studies

Directed studies are available only to French or modern language majors and may be elected provided that (1) the material to be covered is not available in any French course offered during the semester in which directed studies is comtemplated, (2) instructors are willing to undertake a directed studies, and (3) no more than 9 credits in the major field are acquired in directed studies courses.

50-491 DIRECTED STUDIES IN FRENCH LITERATURE

Individual research projects in French literature. The student through regular and frequent consultation with his instructor develops a course of directed study in French literature and defines a problem for individual research. The student's findings are presented in a paper of significant proportions. Prerequisite: permission of instructor. 3 cr.

50-492 DIRECTED STUDY IN COMPOSITION

The student through regular and frequent consultation with his instructor pursues a special problem of composition or creative expression. Prerequisite: permission of instructor. 3 cr.

50-495 ADVANCED TUTORIAL IN FRENCH
A program of directed studies which affords the advanced student with an additional opportunity to pursue a previously explored problem in greater depth or to initiate a new problem. The purpose is to sharpen and refine techniques for scholarly research and presentation and for creative expression. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

Practicum

50-496 PRACTICUM EXPERIENCE
A program of on-campus and/or off-campus experiences (for French and modern language majors only). Specific requirements will vary, depending upon department policies and the nature of the progam undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural, or artistic area and for applying techniques of problem solving and/or skills which are appropriate to the student's major discipline. May be repeated to a maximum of 9 credits. Students will be graded "satisfactory" or "unsatisfactory". The practicum experience may not be substituted for a required course in the major. Prerequisite: permission of department chairperson. 3 cr.

German (Course Prefix: 51)

51-101 BEGINNING GERMAN I*
Development of fundamental skills in oral expression, aural comprehension, reading and writing. Tapes available for laboratory use. Students who have completed more than one year of German at the secondary level are ineligible for this course. 3 cr.

51-102 BEGINNING GERMAN II*
A continuation of 51-101, which is a prerequisite. 3 cr.

51-113 SCIENTIFIC GERMAN I
Introductory course designed for students who wish to acquire facility in translating scientific material from German to English. Introduction to fundamentals of grammar, problems of syntax and idiom, with emphasis on scientific terminology. 3 cr.

51-114 SCIENTIFIC GERMAN II
A continuation of 51-113, which is a prerequisite. 3 cr.

51-211 INTERMEDIATE GERMAN I*
A review of German grammar and syntax with emphasis upon increased proficiency in reading, aural comprehension and oral exprression. This course is intended for students who have completed two years of high school German, preferably during their junior and senior years, or 51-102. 3 cr.

51-212 INTERMEDIATE GERMAN II*
A continuation of 51-211, which is a prerequisite, with emphasis upon continued development of comprehension and conversational skills. 3 cr.

* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

Directed Studies

Directed studies are available only to modern language majors and may be elected provided that (1) the material to be covered is not available in any German course offered during the semester in which the directed studies is contemplated, (2) instructors are willing to undertake a directed studies, and (3) no more than 9 credits of the modern language major are acquired in directed studies courses.

51-491 DIRECTED STUDY IN GERMAN LITERATURE
Individual research projects for modern languages. The student through regular and frequent consultation with his instructor develops a course of directed study in German literature and defines a problem for individual research. The student's findings are presented in a paper of significant proportions. Prerequisite: permission of instructor. 3 cr.

51-492 DIRECTED STUDY IN GERMAN COMPOSITION
Individual research projects for modern language majors. The student through regular and frequent consultation with his instructor pursues a special problem of composition or creative expression. Prerequisite: permission of instructor. 3 cr.

51-495 ADVANCED TUTORIAL IN GERMAN
A program of directed studies which affords modern language majors with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. The purpose is to sharpen and refine techniques of scholarly research and presentation and for creative expression. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

Practicum

51-496 PRACTICUM EXPERIENCE
A program of on-campus and/or off-campus experiences (for modern language majors only) which are developed by the student in consultation with a member of the German staff. Specific requirements will vary, depending upon the nature of the program undertaken by the student. The intent of the practicum is to provide an occasion for investigation of a community, social, cultural, or artistic area and for applying techniques of problem solving and/or skills which are appropriate to the modern language concentration. May be repeated to a maximum of 9 credits in practicum courses. Students will be graded "satisfactory" or "unsatisfactory". The practium experience may not be substituted for a required course in the major. Prerequisite: permission of department chairperson. 3 cr.

Greek (Course Prefix: 55)

55-101 BEGINNING GREEK I*
No previous knowledge of Greek required. The aims are basic oral expression, aural comprehension, and elementary reading and writing in modern and ancient Greek. Bentas. 3 cr.

55-102 BEGINNING GREEK II*
Continuation of 55-101, with readings in Greek prose and poetry. The course provides a foundation for advanced study in modern or classical Greek. Prerequisite: 55-101, or equivalent and permission of instructor. Bentas. 3 cr.

* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

55-211 INTERMEDIATE GREEK I*
Review and development of audio-lingual skill, writing and reading in Greek, followed by the reading of Greek texts from the classical, Byzantine and modern periods. Prerequisite: 55-101,102 or equivalent, and permission of instructor. Bentas. 3 cr.

55-212 INTERMEDIATE GREEK II*
Continuation of 55-211. Bentas. 3 cr.

55-301 GREEK CLASSICS I
Concentrated readings in such authors as Homer, Herodotus, Xenophon, Plato and the dramatists. Prerequisite: 55-212 or equivalent, and permission of instructor. Bentas. 3 cr.

55-302 GREEK CLASSICS II
Continuation of 55-301. Prerequisite: 55-212, or equivalent and permission of instructor. Bentas. 3 cr.

55-303 SELECTED GREEK AUTHORS
Intensive study of a few works of an author not previously studied. May be repeated for credit with approval of instructor. Bentas. 3 cr.

55-310 SPECIAL TOPICS IN GREEK STUDIES
A limited topic of special interest in culture, civilization, or literature. May be taught in English or Greek. Course content and approach will vary, depending on instructor. The department will post and distribute a detailed course description each semester, and students are urged to use this information in making their selections. 3 cr.

The following courses are conducted in English and do not satisfy any language requirement:

55-251 GREAT BOOKS OF ANCIENT GREECE
A study in the meaning and importance of the Greek masterpieces, which are read in the best translations. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

55-252 GREAT BOOKS OF ANCIENT GREECE
Continuation of 55-251. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

55-351 CLASSICAL DRAMA
Group readings of great plays; discussion of their meaning and importance; lectures on the Greek theatre; the origins of tragedy and comedy, the nature of drama, and the special achievements of each dramatist. Prerequisite: consent of instructor. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

55-451 GREEK THOUGHT
The Greek view of man and nature as revealed in myth, philosophy, science, history, art, and literature, and their relation to the modern age. Prerequisite; consent of instructors. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

Italian (Course Prefix: 52)

52-101 BEGINNING ITALIAN I*
Development of fundamental skills in oral expression, aural comprehension, reading and writing. Tapes available for laboratory use. Students who have completed more than one year of Italian at the secondary level are ineligible for this course. 3 cr.

52-102 BEGINNING ITALIAN II*
A continuation of 52-101, which is a prerequisite. 3 cr.

52-211 INTERMEDIATE ITALIAN I*
A review of Italian grammar and syntax with emphasis on increased proficiency in reading, aural comprehension, and oral expression. This course is intended for students who have completed two years of high school Italian, preferably during their junior and senior years, or 52-102. 3 cr.

52-212 INTERMEDIATE ITALIAN II*
A continuation of 52-211, which is a prerequisite, with emphasis upon continued development of comprehension and conversational skills. 3 cr.

52-310 SPECIAL TOPICS IN ITALIAN STUDIES
A limited topic of special interest in culture, civilization, or literature. May be taught in English or Italian. Course content and approach will vary, depending on instructor. The department will post and distribute a detailed course description each semester, and students are urged to use this information in making their selections. 3 cr.

The following courses are conducted in English and do not satisfy any language requirement and cannot be counted as part of the modern language major.

52-371 DANTE'S DIVINE COMEDY
A detailed study of the Divine Comedy. Consideration is given to the influence of Dante's minor works, to the unity of the poem as a synthesis of Dante's new life, and to Dante's views of the world and history. Conducted in English. Aste. 3 cr.

52-373 ITALIAN HUMANISM
A study of the waning of the Middle Ages and the dawning of the Renaissance as seen through the work of Petrarch and Boccaccio. Emphasis will be given to the study of sources and to the influence of Petrarch and Boccaccio upon the literatures of western Europe. Conducted in English. Aste. 3 cr.

52-376 PIRANDELLO: HIS THEATER AND INFLUENCE
A course devoted to the major works of Pirandello which have established his reputation as an entertainer and a social critic, with special emphasis upon his notion of appearance vs. reality and his influence upon contemporary French drama. Conducted in English. Aste. 3 cr.

52-378 ITALIAN CULTURE THROUGH CINEMA AND LITERATURE
A guide to contemporary Italian studies, through literary and cultural approaches. The works of central figures in contemporary Italian letters will be examined in view of their impact on Italian life. Emphasis will be given to poets, novelists, the new cinema, the in-

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* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

fluences of existentialism, and the impact of America on Italian literature. Conducted in English. Aste. 3 cr.

Directed Studies

Directed studies are available only to modern language majors and may be elected provided that (1) the material to be covered is not available in any Italian course offered during the semester in which directed studies is contemplated, (2) instructors are willing to undertake a directed studies, (3) no more than 9 credits of the modern language major are acquired in directed studies courses.

52-491 DIRECTED STUDY IN ITALIAN LITERATURE
Individual research projects for modern language majors. The student through regular and frequent consultation with his instructor develops a course of directed study in Italian literature and defines a problem for individual research. The student's findings are presented in a paper of significant proportions. Prerequisite: permission of instructor. 3 cr.

52-492 DIRECTED STUDY IN ITALIAN COMPOSITION
Individual research projects for modern language majors. The student through regular and frequent consultation with his instructor pursues a special problem of composition or creative expression. Prerequisite: permission of instructor. 3 cr.

52-495 ADVANCED TUTORIAL IN ITALIAN
A program of directed studies which affords modern language majors with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor.

Practicum

52-496 PRACTICUM EXPERIENCE
A program of on-campus and/or off-campus experiences (for modern language majors only) which are developed by the student in consultation with a member of the Italian staff. Specific requirements will vary, depending upon the nature of the program undertaken by the student. The intent of the practicum is to provide an occasion for investigation of a community, social, cultural, or artistic area and for applying techniques of problem solving and/or skill which are appropriate to the modern language concentration. May be repeated to a maximum of 9 credits in the practicum courses. Students will be graded "satisfactory" or "unsatisfactory". The practicum may not be substituted for a required course in the major. Prerequisite: permission of department chairperson. 3 cr.

Latin (Course Prefix: 56)

56-101 BEGINNING LATIN I*
A course for beginners and for students wishing to review the elements of Latin, and to acquire, thereby, an ability to read selected passages from Latin authors. 3 cr.

56-102 BEGINNING LATIN II*
Continuation of 56-101, with special attention devoted to the translation, analysis and class discussion of selected passages from Latin authors illustrating the life, culture, and contribution of ancient Rome to the modern world. 3 cr.

* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

56-211 INTERMEDIATE LATIN I*
Readings from Latin prose and poetry, with special attention to the works of such authors as Cicero and Virgil. Prerequisite: 56-101,102. 3 cr.

56-212 INTERMEDIATE LATIN II*
Continuation of 56-211. 3 cr.

56-301 LATIN CLASSICS I
Concentrated readings in such authors as Livy, Tacitus, Horace, Juvenal, Catullus, Ovid, and medieval Latin writers. Prerequisite: 56-101,102, or four years of high school Latin. Bentas. 3 cr.

56-302 LATIN CLASSICS II
Continuation of 56-301. Bentas. 3 cr.

56-303 SELECTED LATIN AUTHORS
Intensive study of a few works of an author not previously studied. May be repeated for credit with approval of instructor. Bentas. 3 cr.

56-310 SPECIAL TOPICS IN LATIN STUDIES
A limited topic of special interest in culture, civilization, or literature. May be taught in English or in Latin. Course content and approach will vary, depending on instructor. The department will post and distribute a detailed course description in making their selections. 3 cr.

56-352 CLASSICAL DRAMA
Continuation of 55-351 with concentration on the Roman dramatists. Prerequisite: consent of instructor. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

56-451 THE ROMAN MIND
The Roman view of man and nature as revealed in law, government, social institutions, legend, and religion, and their relation to the modern world. Prerequisite: consent of instructor. (Subject to demand of classical civilization minors.) Bentas. 3 cr.

Spanish (Course Prefix: 54)

54-101 BEGINNING SPANISH I*
Development of fundamental skills in oral expression, aural comprehension, reading and writing. Tapes available for laboratory use. Students who have completed more than one year of Spanish at the secondary level are ineligible for this course. 3 cr.

54-102 BEGINNING SPANISH II*
A continuation of 54-101, which is a prerequisite. 3 cr.

54-103 CONVERSATIONAL SPANISH FOR HEALTH PROFESSIONS
Fundamental skills in conversation for the health professions (semi-technical functional vocabulary, idiomatic expressions used by patients and doctors, and situational phrases for the health professions) with special emphasis upon those cultural and physiological characteristics of Spanish speaking peoples which influence their behavior in a health profession's setting. 3 cr.

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* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

54-114 SPANISH FOR BUSINESS AND INTERNATIONAL MANAGEMENT
A continuation of 54-101 with a reading emphasis presenting to business and management concentrators and others, by means of a cultural comparison between the Hispanic and American peoples, the terminology and practices of the Hispanic business world, particularly in the domains of accounting, banking, management and legal organization.

54-211 INTERMEDIATE CONVERSATIONAL SPANISH I*
A review of Spanish grammar and syntax with emphasis upon increased proficiency in aural comprehension, and oral expression. This course is intended for students who have completed two years of high school Spanish, preferably during their junior and senior years, for students who have completed 54-102, and for students who are unqualified for the 221-222 sequence. 3 cr.

54-212 INTERMEDIATE CONVERSATIONAL SPANISH II*
A continuation of 54-211, which is a prerequisite, with emphasis upon continued development of comprehension and conversational skills. Required of Spanish concentrators. 3 cr.

54-213 INTERMEDIATE CONVERSATIONAL SPANISH III*
Designed for Criminal Justice majors, this course may replace 54-212, the second portion of the intermediate sequence. Continued development of comprehension and conversational skills will be emphasized. Students will work with relevant technical vocabulary and highly idiomatic "street" language. Cultural information will emphasize characteristics of Spanish-speaking population in the United States. 3 cr.

54-221 READING AND CONVERSING IN SPANISH I
The basic emphasis of this course is upon Spanish grammar review and the development of reading and conversational skills. Selected contemporary works provide the basis for developing conversational comprehension, conversational, and composition skills. This course is intended for students with a solid foundation in the Spanish language which has been gained from at least three years of high school study immediately prior to admission to the University. 3 cr.

54-222 READING AND CONVERSING IN SPANISH II
A continuation of 54-221, which is a prerequisite, with emphasis upon continued development of reading and conversational skills. Required of Spanish concentrators. 3 cr.

54-234 ADVANCED SPANISH GRAMMAR AND SYNTAX
A systematic study of complex grammatical and syntactical problems. Review of more advanced problems. 3 cr.

54-245 ADVANCED SPANISH CONVERSATION
Advanced oral fluency in rapid and idiomatic speech. Topics of contemporary significance will be selected from contemporary prose. Required of Spanish concentrators. 3 cr.

54-254 TOPICS IN CONVERSATIONAL SPANISH
Discussion of a wide spectrum of contemporary topics with the object of continuing to develop facility and accuracy of expression. Prerequisite: advanced level proficiency. 3 cr.

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* Beginning and intermediate language courses at the 101-102 and 211-212 levels must be elected for two consecutive semesters and in the prescribed sequence. College credit may not be granted for one semester of such courses unless exception is permitted by the chairperson of the Department of Language on the basis of student placement in a more advanced language course.

54-301 INTRODUCTION TO SPANISH LITERATURE
The history of Spain's literature studied in its general trends and through its major writers, revealing the complicated series of interactions, conflict and influences which have molded the unique character of the nation. Conducted in Spanish. Permission of instructor required. 3 cr.

54-302 INTRODUCTION TO LATIN AMERICAN LITERATURE
A study of the major writers of Latin America from the indigenist literature to the modernist period. The authors and their works will be placed in their historical, sociological, and literary perspective, thus introducing students to the Latin American world. Conducted in Spanish. Permission of instructor required. 3 cr.

54-310 SPANISH CIVILIZATION AND CULTURE
The course considers Spanish culture and civilization up to the present. Through audiovisual aids, current newspapers and selected readings, the student will explore the Spanish way of being, thinking, and living. Emphasis is placed on the main contributions of Spain to the Western world. 3 cr.

54-313 FIELDWORK IN THE SPANISH COMMUNITY
Individual assignments under the sponsorship of local service agencies servicing the Spanish speaking community, involving individual family and group contact. Written and oral reports in Spanish. Prerequisite or corequisite: 54-212, or equivalent. 3 cr.

54-315 LATIN AMERICAN CIVILIZATION AND CULTURE
This course considers significant intellectual, artistic, historical and socio-political aspects of Latin America from the beginning of its history. Through audiovisual aids and selected readings, the student will explore the way of being and expressing of Latin America.3 cr

54-320 SPECIAL TOPICS IN SPANISH STUDIES
A limited topic of special interest in culture, civilization, or literature. May be taught in English or in Spanish. Course content and approach will vary, depending on instructor. The department will pose and distribute detailed course descriptions each semester, and students are urged to use this information in making their selections. Permission of instructor required. 3 cr.

54-347 ADVANCED SPANISH COMPOSITION
A course designed to help the mature language student recognize and interpret a variety of literary styles. Also designed to develop self-expression and facility in prose writing. Required of Spanish concentrators. 3 cr.

54-350 INRODUCTION TO LITERARY ANALYSIS
This course will focus on acquiring the technical vocabulary, concepts and methods of literary criticism. Through the analysis of selected Spanish literature, the student will gain an understanding of the different literary genres as well as a knowledge of their structure and artistic qualities. Required for all Spanish concentrators. 3 cr.

54-372 APPLIED LINGUISTICS
Linguistics analysis of Spanish phonology, morphology, and syntax, with a systematic comparison of the structures of Spanish and English. Required for prospective teachers of Spanish in the elementary and secondary schools. 3 cr.

54-401 SELECTED AUTHORS
An intensive study of works by a few Spanish and/or Latin American authors. 3 cr.

54-403 THE GOLDEN AGE
A study of the development and character of XVIIth century Spanish drama, novel and

poetry, with special emphasis on Cervantes, Lope de Vega, Calderon and Quevedo. An analytical study of some of the masterpieces from structural and stylistic points of view, taking into consideration their relation to the period and the expression of universal values. Prerequisite: 54-350 or permission of instructor. 3 cr.

54-405 THE GENERATION OF '98

A critical study of such influential authors as Unamuno, Valle-Inclan, Baroja, Azorin, and Machado. Special emphasis is given to their influence upon the emergence of modern Spain. Prerequisite: 54-350 or permission of instructor. 3 cr.

54-407 SPANISH PICARESQUE NOVEL

Analysis of representative works of the picaresque genre, its portrait of Spanish society, social criticism. Emphasis will be placed on Ellazarillo de Tormes, Guzman de Alfarache, El Buscon and Riconete y Cortadillo. Prerequisite: 54-350 or permission of instructor. 3 cr.

54-409 TWENTIETH CENTURY SPANISH LITERATURE

A study of the famous generation of 1927 and of the major literary trends during and after the Spanish Civil War. Prerequisite: 54-350 or permission of instructor. 3 cr.

54-410 REALISM AND THE XIX CENTURY SPANISH NOVEL

A study of fundamental aspects of life, thought, land itself and its sense of history as reflected in the literary masterpieces of Valera, Galdos, Alarcon, Pereda and others. An analysis of the literary techniques and fiction of the Realism will be included. Prerequisite: 54-315, or permission of instructor. 3 cr.

54-412 THE SHORT STORY IN LATIN AMERICA

An analytical examination of the thematic and linguistic structures in major Latin American short story writers such as Borges, Cortazar, Marquez, Rulfo. Prerequisite: 54-350 or permission of instructor. 3 cr.

54-416 THE LATIN AMERICAN NOVEL

The study of the development of the Latin American novel. Three major works (Dona Barbara, Los de Abajo, and Don Sequndo Sombra) will be read and analyzed in depth and placed in the historical context of the novel in Latin America. Prerequisite; 54-350 or permission of instructor.

54-456 SPANISH TRANSLATION SEMINAR

A study of the theory and practice of translation, aimed at developing translation skills. Material used is taken from literary works as well as newspapers and magazines. This course is intended for students with a good command of the language. Open to Spanish concentrators and others by permission of instructror. 3 cr.

Directed Studies

Directed studies are available only to Spanish or modern language majors and may be elected provided that (1) the material to be covered is not available in a Spanish course offered during the semester in which a directed studies course is contemplated, (2) instructors are willing to undertake a directed studies course, and (3) no more than 9 credits in the major field are acquired in directed studies courses.

54-491 DIRECTED STUDY IN SPANISH LITERATURE

The student, through regular and frequent consultation with his instructor develops a course of directed studies in Spanish literature and defines a problem for individual research. The student's findings are presented in a paper of significant proportions. Prerequisite: permission of instructor. 3 cr.

54-492 DIRECTED STUDY IN LATIN AMERICAN LITERATURE
The student, through regular and frequent consultation with his instructor develops a course of directed studies in Spanish literature and defines a problem for individual research. The student's findings are presented in a paper of significant proportions. Prerequisite: permission of instructor. 3 cr.

54-493 DIRECTED STUDY IN COMPOSTION
The student, through regular and frequent consultation with his instructor, pursues a special problem in composition or creative expression. Prerequisite: permission of instructor. 3 cr.

54-495 ADVANCED TUTORIAL IN SPANISH
A program of directed studies which affords the advanced students with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. The purpose is to sharpen and refine techniques for scholarly research and presentation and for creative expression. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

Practicum

54-496 PRACTICUM EXPERIENCE
A program of on-campus and/or off-campus experiences for Spanish or modern language majors only. Specific requirements will vary, depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural, or artistic area and for applying techniques of problem solving and/or skills which are appropriate to the student's major descipline. May be repeated to a maxumum of 9 credits. Students will be graded "satisfactory" or "unsatisfactory". The practicum experience may not be substituted for a required course in the major. Prerequisite: permission of Department Chairperson. 3 cr.

DEPARTMENT OF PHILOSOPHY

Eugene Mellican, Chairperson

Professors: Veda Cobb-Stevens, Robert E. Innis, Arthur I. Miller, P. Christopher Smith

Associate Professors: Robert B. Wagner

Assistant Professors: Eugene Mellican

The Department of Philosophy offers a major in philosophy which leads to the Bachelor of Arts degree. The department also offers a minor in philosophy.

The majority of students in the University will neither major nor minor in philosophy. Accordingly, the department has so structured its course offerings that they intersect with issues and problems treated in other disciplines, from the natural sciences through engineering to the social sciences and the other humanities. The department is especially concerned to show the interrelationships not only between different areas of knowledge but also between different areas of existence, both individual and social. As such, it wants to counteract the fragmentation of knowledge and life that is a mark of modernity. Consequently, its courses are designed to appeal to the broadest range of students and to continue philosophy's traditional role as indispensable integrator in the University's curriculum.

Philosophy Major

The major in philosophy is designed to serve the needs of three types of students: (1) those who seek a liberal arts education as a terminal program; (2) those who are preparing for professional graduate schools, e.g. education, law, theology, and medical schools which approve an undergraduate philosophy major; and (3) those who are preparing for graduate work in philosophy. Regardless of the goals which undergraduates may have set for themselves, a major in philosophy should be of value to all who question the reasons for things as they are, to those who seek a deeper understanding of what they are doing and for what purpose they are doing it, and to those who recognize the validity of Socrates' assertion that the "unexamined life is not worth living".

A major in philosophy consists of 30-45 credits (with at least 15 credits at the 300 level or above). The department does not specify particular course work for the major but recommends that the sequence of courses be designed in close consultation with the student's faculty advisor. Students who plan to go to graduate school are encouraged to take a second major in a cognate field, e.g., American studies, English, French, history, mathematics, or political science.

Students transferring to the college and wishing to major in philosophy must make individual arrangements with the chairperson of the Department of Philosophy regarding satisfaction of major course requirements.

Philosophy Minor

A minor area of study consists of 18-24 credits of course work in philosophy. At least 6 credits must be selected from courses which are numbered 300 or above.

Philosophy (Course Prefix: 45)

45-201 INTRODUCTION TO PHILOSOPHY
An examination of some of the typical approaches to philosophical questioning and the issues raised in such inquiry: what is knowledge, what is the good, what is the right political order, what is the nature of religious faith? Members of the department. 3 cr.

45-202 INTRODUCTION TO LOGIC
A course designed to study the methods used to distinguish correct from incorrect argument. It will aim at developing (1) an ability to express one's ideas clearly and concisely, (2) an increased skill in defining one's terms, and (3) a capacity to formulate arguments vigorously and to scrutinize them critically. Members of the department. 3 cr.

45-203 INTRODUCTION TO ETHICS
An examination of the basic issues and problems of ethics and value; and a survey of some important alternative answers to the questions raised, on both an individual and a social level, by our necessity to act and to live in a rational and human way. Members of the department. 3 cr.

45-206 INTRODUCTION TO POLITICAL PHILOSOPHY
Revolutionary and conservative tendencies in the history of political philosophy will be compared and their development traced. Plato, Aristotle, Hobbes, Locke, Rousseau, Hegel, Marx, Lenin, Burke, and Marcuse will be considered. Smith. 3 cr.

45-215/220 STUDIES IN THE HISTORY OF PHILOSOPHY
Great figures, periods or problems in the history of philosophy will be subjected to an extensive semester long examination. Members of the department. 3 cr.

45-225 ORIENTAL PHILOSOPHY
An examination of basic texts from the Indian, Chinese and Japanese traditions. An attempt will be made to understand these texts by relating them to works of Westerners who have dealt with comparable themes (Heidegger, Rilke, Thoreau). Smith. 3 cr.

45-281 SYMBOLS AND SOCIETY
The central task of this course will be the philosophcal examination of a variety of social symbols (verbal, visual and praxic) in terms of their relations to modes of social control or influence and to perceptions of social realities. This inquiry will be carried out by exploring the dynamics of social symbols in traditional non-literate societies as well as in literate technological societies, in order to understand how people both affect and are affected by the symbol systems among which they live their lives. Topics to be considered include myth, folklore, painting, photography, advertising and propaganda. Cobb-Stevens. 3 cr.

45-284 PHILOSOPHIES OF ART AND BEAUTY
This course will examine the views of major philosophers on the beautiful and the nature of artistic creativity. Among others, Plato, Aristotle, Augustine. Hegel, Nietzsche and Dewey will be considered. An attempt will be made to correlate the views of the thinkers with the works of poets, artists and composers and the statements the latter have made about their work. Smith. 3 cr.

45-293 PLATO AND THE BEGINNINGS OF PHILOSOPHY
This course will be concerned with Plato's attempt to deal with the questions raised by the first Greek philosophers. Special emphasis will be given to the following of Plato's dialogues: the Gorgias, Symposium, Phaedrus, Sophist and Philebus. Particular attention will be paid to Plato's teachings on justice, eros, pleasure, and knowledge. Smith. 3 cr.

45-295 ETHICAL ISSUES IN TECHNOLOGY
This course will examine important ethical issues and value conflicts emerging in contemporary science and technology. Through readings and class discussions, students will not only have an opportunity to explore the manner in which ethical and technical problems are related, but to develop insight into the problems of ethical philosophy and the modes of reasoning essential to an intelligent understanding of such issues. Mellican. 3 cr.

45-296 THE RELIGIOUS EXPERIENCE OF MANKIND
A study of religious knowledge and the phenomena of religion from a philosophical standpoint. The course will consider explanations for religious behavior, some central issues in religious belief, and the values and goals of religious systems. Various world religions will provide specific data for these topics. Wiehe. 3 cr.

45-297 MYTHOLOGY AND PHILOSOPHICAL THOUGHT IN INDIA
Much of Indian thought about reality, ultimate existence and human values is found in extended narratives, such as the Mahabharata and Ramavana, which furnish also part of the sacred teachings of the Hindus and early Buddhists. This course will explore the interrelationships of Indian mythological thinking and of formal philosophical ideas found in the six classical schools of Indian philosophy with the work of individual thinkers such as Shankara or Ramanuja. Wiehe. 3 cr.

45-300 PHILOSOPHY AND SOCIETY
An examination of the shifting nature of the chief material, symbolic, and normative premises of social, historical, and cultural processes. The course will study the interactions and intesections between the various formations in which human life objectifies itself, and will investigate the tensions and distortions to which they are subject. Innis. 3 cr.

45-301 THEORY OF KNOWLEDGE

The course will study and analyze various forms and expressions of human knowledge (perception, concept-formation and symbolic functioning, myth, aesthetic creation and interpretation, scientific discovery and understanding) and the individual, social and historical conditions to which they are subject. The goal of the course is a comprehensive view of the structure of the human mind and its operations. Innis. 3 cr.

45-302 EXISTENCE AND ANXIETY

A survey of existential philosophy and literature with reference to the traditional philosophy which existentialism calls into question. Kafka, Camus, Buber, Rilke, Nietzsche and Musil will be discussed. Smith. 3 cr.

45-303 PHILOSOPHY AND TECHNOLOGY

A philosophically oriented systematic examination of the chief aspects— material, economic, political, cultural, aesthetic, ethical—of the process by which the human race rates and embodies itself in tools and instruments. Innis. 3 cr.

45-304 GOD AND PHILOSOPHY

The course will study, historically and systematically, the following topics: (a) the origin and content of the idea of God, (b) the possibility of affirming God, philosophically and religiously, (c) the complex nature of religious language and imagery, (d) God's relation to the world, history and the individual. Innis. 3 cr.

45-305 LANGUAGE, SIGNS AND SYMBOLS

An examination of the various grammars of human expressions from the point of view of a general theory of signs. Among the topics to be treated are: (a) the nature of signs, symbols, and meaning, (b) the structures and functions of language, (c) the relations between language, thought and reality, especially as manifested in metaphor, (d) the social dimensions of signification and symbolization, (e) the relations between the different linguistic, sign, and symbol systems. Innis. 3 cr.

45-306 RELIGIOUS EXISTENTIALISM

In considering the works of Pascal, Kierkegaard and Heidegger an attempt will be made to work out a possible response to Nietzsche's radical challenge to the Judeo-Christian tradition. Smith. 3 cr.

45-307 FROM MYTH TO PHILOSOPHY

The transition from mythological modes of thought to the kind of philosophical inquiry which was to set the stage for the intellectual development of the West began in Greece during the 6th century B.C. The aim of this course will be to trace in detail the nature of this transition, beginning with the foundations of the mythological outlook in the Homeric poems, continuing with Hesoid, Theognis and the lyric poets, and culminating with an examination of the theories of the presocratic philosophers. Reading and discussion of the texts will be done with a view toward specifying the gradual changes in conceptual frameworks which made possible new notions of the divine and of the cosmos, of the human self and of human institutions. Cobb-Stevens. 3 cr.

45-308 PHILOSOPHY OF LAW AND PROBLEMS IN CRIMINAL JUSTICE

An introduction to philosophical principles and theories underlying the institutions of law and criminal justice. Students will: (1) study the purpose and functions of law in a democratic society, (2) examine the philosophical grounds for authority and legal obligation, (3) analyze and attempt to resolve the longstanding dispute between the utilitarian and retributive theories of criminal justice, (4) evaluate the concepts of punishment, rehabilitation, and treatment in dealing with criminal behavior, and (5) assess the philosophical basis of current problems and issues confronting the criminal justice system. Members of the department. 3 cr.

45-309 LOGIC AND LANGUAGE

An examination of the role of language in logical reasoning. Special attention will be given to the properly rhetorical elements in logical argumentation. General topics of logic will be studied from a novel point of view. Smith. 3 cr.

45-310 PHILOSOPHY OF THE CREATIVE IMAGINATION

This course will focus first on imagination as a function of mind, placing it in relation to other functions such as perception, emotion and conceptualization. Attention will then be given to the difference between the reproductive and the creative imagination, with special emphasis on the psychological and social/political dimensions of creativity. Topics to be considered include poetical metaphor, theatrical performance, painting, architecture or photography. Cobb-Stevens. 3 cr.

45-312 PHILOSOPHY OF SCIENCE

This course will explore ways in which science has been understood in different historical periods. An investigation will be made of the kinds of propositions which are strictly scientific; the methods which are appropriate to scientific inquiry; and the nature, origins and cultural implications of scientific revolutions. In addition, attention will be given to certain key concepts (e.g. space, time, causality) which have played a central role in the history of science, in order to correlate changes in these concepts with developments undergone by the notion of science as such. Miller. 3 cr.

45-313 THE PLATONIC TRADITION

An exploration of the intertwining of the rational and mystic, and philosophical and poetic elements in Aristotle, in Plotinus' Enneads, Goethe's Faust, and the poetry of Holderlin. The course will examine the stages of consciousness as it moves through the limits of "scientific" understanding to re-unification with the divine. Smith. 3 cr.

45-315/325 PHILOSOPHICAL CLASSICS

A close study of some of the great texts of philosophical literature. In general, one or two major works will be selected and subjected to a thorough reading. Members of the department. 3 cr.

45-326 ETHICS AND BUSINESS

Through the study and application of some of the fundamental concepts and principles of traditional and contemporary ethical theories, this course will undertake a philosophical analysis of the diverse and complex ethical issues confronting those engaged in the practice of business. Mellican. 3 cr.

45-327 PHILOSOPHICAL PROBLEMS OF SPACE AND TIME

An inquiry into the development and impact of Albert Einstein's special theory of relativity that focuses on the philosophical and physical transformation of the concepts of space, time and causality. Analysis of these concepts begins with a survey of their status within the philosophical frameworks of Hume, Kant, Newton and Poincare. Readings from contemporaneous sources and from philosopher-scientists of the late 19th and early 20th centuries. Prerequisite 95-425. Miller. 3 cr.

45-328 TOPICS IN PHILOSOPHICAL PROBLEMS OF RECENT SCIENCE

Analysis of the changing philosophical conceptions of space, time, causality and substance brought about by developments in 20th century physical science, such as the special and general theories of relativity, statistical mechanics, nuclear physics, quantum theory, cosmology and elementary-particle physics. The interplay between philosophy and science that is a necessary part of research on the frontiers of science is studied through reading original papers by Bohr, Born, Einstein, Heisenberg, Planck and Schrodinger, among others. The emphasis on subject matter will vary from year to year. Prerequisite: 95-425. Miller. 3 cr.

45-329 PHILOSOPHY AND FOLKLORE

The purpose of this course is to examine various types of folklore (e.g. jokes, riddles, proverbs, stories) from the point of a general philosophical theory of social symbols, on one hand, and of social values, on the other. Attention will be paid to the ways in which traditional verbal forms can encode, perpetuate, or question the basic problems and assumptions of the human community in which they find expression. Cobb-Stevens. 3 cr.

45-330 PHILOSOPHY OF SYMBOLIC LOGIC

The first half of this course will be devoted to the examination of various axiomatic systems, and the student will be required to develop both intrasystematic and metasystematic techniques of proof. During the second half of the course, attention will be given to certain important philosophical problems which arise from reflection on logical systems, e.g., the cognitive processes of abstraction and instantiation, the general notion of form, and questions of consistency and interpretation. Members of the department. 3 cr.

45-341 PHILOSOPHY OF MIND

The status of consciousness is the central concern of a philosophy of mind. The course will take as its point of departure a reflection upon the nature and significance of consciousness, from the perspective of its advocates (Husserl, Sartre) and its adversaries (Ryle, Skinner). The results of this preliminary inquiry will provide a foundation for the exploration of other issues: the possibilty of an unconscious; the temptation of bad faith; the dynamics of concept formation; and the nature of emotion, imagination and dreams. Cobb-Stevens. 3 cr.

45-352 CLASSICAL RHETORIC AND THE THEORY OF ARGUMENTATION

Recent insights into the limits of traditional logic have confirmed that Aristotle was correct when, in distinguishing between the logical syllogism and the rhetorical enthymeme, he implied that in any field of argument outside the pure mathematical sciences there are no certain starting points and no final conclusions and, accordingly, the more useful model would be public speech and discussion, not inference and deduction. In examing the texts of the ancient masters of rhetoric, Aristotle, Cicero, and Quintilian, this course will take up their reflections on the nature of effective argument — forensic, epideictic and deliberative— and thereby attempt to lay bare the foundations of contemporary rhetorical theories. Smith. 3 cr.

45-353 THE LANGUAGE OF GREEK PHILOSOPHY

Instruction in ancient Greek grammar, along with an introduction to selected texts of a given Greek author. Members of the department. 3 cr.

45-360 FEMINIST PHILOSOPHY AND THE QUESTION OF VALUES

One of the principal traditions of Western philosophy involves the formulation of ethical values as well as social/political ideals upon the basis of a general theory of human nature. Feminist philosophers have pointed out that the so called "nature of man" posited by traditional theorists is usually a theory of the nature of men, not women. When women are considered, it turns out that they are either second class citizens or else not citizens at all, a conclusion which is itself often argued for on the thesis of a supposedly distinctive "female nature". This course will examine selected examples of these traditional theorists (e.g., Aristotle, Locke, Rousseau), as well as the key feminist critiques of these theories (e.g., Wollstonecraft, Taylor, Mill, de Beauvoir). Attention will be given not only to the principal ideas of both types of theory, but also to several central problems which arise in value theory as such: the manner of formulating question, of deciding on methodological procedures for answering those questions, and of setting up criteria for assessing the validity of the answers. Cobb-Stevens. 3 cr.

45-401 SEMINAR IN THE PHILOSOPHY OF SCIENCE
Topics vary from year to year and include: the nature of scientific discovery; case studies on the scientist as philosopher; philosophy of quantum mechanics. Prerequisite: permission of instructor. Miller. 3 cr.

45-405 SEMINAR IN FEMINIST THEORY
An examination of a variety of trends in comtemporary feminist theory as they are articulated in a number of fields, e.g. political philosophy, theology, psychoanalysis. Specific texts and topics will vary from year to year. Prerequisite: 45-360 or permission of the instructor. Cobb-Stevens. 3 cr.

Directed Studies

Directed Studies courses are available only to majors in philosophy and may be elected provided that (1) the material to be covered is not available in any course offered during the semester in which a directed studies course is contemplated, (2) instructors are willing to undertake a directed studies course, and (3) no more than 9 hours of credit in the major field is acquired through registration for and completion of directed studies courses. 3 cr.

45-491 DIRECTED STUDY IN PHILOSOPHY
The student through regular and frequent consultation with an instructor pursues a special problem in philosophy, the results of which are presented in a 25-30 page paper. Prerequisite: permission of instructor. 3 cr.

45-495 ADVANCED TUTORIAL IN PHILOSOPHY
A program of directed studies which affords the advanced student with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. The purpose is to sharpen and refine techniques for scholarly research and presentation. Prerequisite: demonstrated proficiency in an area selected for directed studies and permission of instructor. 3 cr.

DEPARTMENT OF POLITICAL SCIENCE

Frederick Lewis, Chairperson

Professors: Frederick Lewis, Joan Rothschild

Associate Professors: Joyce Denning, H.B. Pho

Assistant Professors: Barbara Dowd, William Lindeke, A. N. Minton, Christine Rideout

The Department of Political Science offers a major in political science leading to the Bachelor of Arts degree and minor programs in public affairs and political science. In cooperation with other departments, the department offers an interdisciplinary minor in legal studies.

Political Science Major

The major in political science is designed to provide a knowledge of the functions and theories of the state and the nature, problems, and development of politics and government on the local, national, and international levels. The courses are designed to help the student develop an understanding of the political process and an ability to analyze political systems, relationships, and problems. Pragmatically, the major affords preparation for social science teaching, graduate education, law school, public administration, public service, and intelligent citizenship.

Overall credit hour requirement: A major in political science consists of 36 credits (i.e., a 3 credit Practicum and 33 other credits) to a maximum of 45 credits. At least 15 credits must be taken at the 300 course level or above.

Specific course requirements:

1. 46-101 Introduction to American Politics; normally taken fall semester of the freshman year.
2. 46-201 Introduction to Political Analysis. This course meets the human values requirement of the University core curriculum for political science majors; normally taken spring semester of the freshman year.
3. 46-301 Research Methods in Political Science; normally taken spring semester of junior year.
4. 46-401 Research Seminar in Politics; requires the writing of a substantial thesis paper. Normally taken fall semester of senior year.
5. One 3 credit Practicum course which will be graded “satisfactory” or “unsatisfactory”. Take either 44-496 Practicum Experience, or 44-497 Practicum in the Law, or another practicum if offered. The practicum involves 75-100 hours of practical experience in politics, government, law, etc. No student may take more than one practicum as part of the minimum 120 credits required for graduation without prior department approval.

Distribution requirement: the department also requires at least one course in each of the following areas: (1) American Politics and Law, (2) Comparative Politics, (3) Political Thought and Theory, (4) International Politics, (5) Public Policy and Administration.

Focus requirement: In conjunction with the faculty advisor, political science majors are expected to formulate a program of study in the major that includes three to five courses that focus in a progressively more advanced manner upon one political science sub-area to assure a depth of knowledge. Sub-areas may be defined flexibly.

Waivers: Waiver of any requirement may be granted only by the department chair in unusual circumstances and for very good reasons.

The department recommends that political science majors select supporting course work from economics, history and sociology and encourages students to develop minor areas of study or supporting majors in related social science disciplines.

Students transferring to the college and wishing to major in political science must make individual arrangements with the chairperson of the department or their faculty advisor regarding satisfaction of major course requirements.

Law

Because many political science majors are interested in pursuing careers in the legal field, the department offers several course opportunities in the legal-political area. In appropriate instances, this may include the arrangement of practicum opportunities that provide exposure to legal practice. Political science majors may also elect the interdisciplinary legal studies minor; however, political science courses utilized for the minor may not also be credited to the major, and the number of political science courses taken for the major and minor together may not exceed 45 credits within the minimum 120 credits required for graduation.

Public Affairs and Public Administration

Many political science majors pursue careers in public affairs on the staffs of elected officials, government agencies, or public interest groups. In the coming years, new opportunities are expected to develop in the private sector as increasing numbers of corporations create or expand their public affairs departments.

Students majoring in the programs of other departments who have a strong academic or career interest in public affairs and public administration may be interested in electing the public affairs minor.

Minor Requirements

Political Science

Political science as a minor area of study consists of 18-24 credits of course work. At least 6 credits must be taken in course work at the 300 level or above. Course work is selected by the student in consultation with his advisor. Students who desire to make the most effective use of a minor in political science in pursuing specific career objectives in occupational areas such as law, foreign service, business, management, and public service should consult with the political science faculty in choosing courses which are most appropriate as preparation for such career objectives.

Public Affairs

A minor course of study organized around the department's offerings in the public affairs—public administration area is available. The minor involves 18-24 credits of course work of which at least 6 credits must be taken at the 300 level or above. Interested students should contact the department for details. Not available to political science majors.

Legal Studies

The department sponsors an interdisciplinary minor involving legally oriented courses in political science as well as in history, sociology, psychology and criminal justice. The minor involves 18-24 credits of course work of which at least 6 credits must be taken at the 300 level or above. See the listing of interdisciplinary minors at the end of the College of Liberal Arts section of this catalogue for a fuller description of the program and a list of applicable courses.

Political Science (Course Prefix: 46)

46-101 INTRODUCTION TO AMERICAN POLITICS
An introduction to the politics, structure and behavior of the American national political community. 3 cr.

46-110 INTRODUCTION TO POLITICS
An introductory exploration of basic political concepts and themes. 3 cr.

46-112 COMPARATIVE POLITICAL SYSTEMS
A cross-cultural analysis of various governmental systems; elements common to all forms of government are emphasized and variations among contemporary political systems are discussed. 3 cr.

46-121 INTRODUCTION TO INTERNATIONAL RELATIONS
A survey of some recent methods and approaches used in the study of international politics and the introduction of current problems of foreign policies of major world powers. 3 cr.

46-131 INTRODUCTION TO POLITICAL THOUGHT
An examination of the concepts, ideas, theories and ideologies of politics - ancient and modern and across cultures. 3 cr.

46-201 POLITICAL ANALYSIS
Introduces the political science major to the scope of politics as a discipline. Highlights value questions through analysis of the political, socio-demographic and constitutional background of selected contemporary public issues and policies. 3 cr.

46-203 TECHNOLOGY AND HUMAN VALUES I
Same as 59-203. 3 cr.

46-204 TECHNOLOGY AND HUMAN VALUES II
Same as 59-204. 3 cr.

46-205 SCIENCE, TECHNOLOGY AND POLITICS
The relationship between the political process and contemporary issues in science and technology is examined through selected case studies of policy formulation and implementation, as well as other readings. 3 cr.

46-207 AMERICAN ENVIRONMENTAL POLICY
Attitudes, policies, and behavior of Americans and their government towards the environment. Special attention to current issues evolving out of our past attitudes and policies. Cross-listed with 43-207. 3 cr.

46-211 COMPARATIVE EUROPEAN POLITICS
An analytical examination of selected modern European political systems, emphasizing similarities and differences in political culture, political behavior, political institutions, and political performance. 3 cr.

46-216 SOUTHEAST ASIAN POLITICS
Survey of Southeast Asian countries including Indonesia, Thailand and Vietnam. Review of the anti-colonial struggles and examination of the patterns of nation-building during the recent, post-colonial period. 3 cr.

46-230 LAW AND THE LEGAL SYSTEM
An introduction to the nature of the legal process and the operation of the American legal system; consideration of its political and social functions. 3 cr.

46-238 AMERICAN POLITICAL THOUGHT
A survey of American political thought with emphasis upon selected thinkers and their contributions to the development of concepts and ideas basic to the American political culture. Among thinkers considered are Paine, Jefferson, Madison, Hamilton, Emerson, Brownson, Calhoun, Fitzhugh, Sumner, Bellamy, Croly, Dewey, Dahl, and Marcuse. 3 cr.

46-240 CONTEMPORARY POLITICAL THEORY
An examination of major ideological currents in the contemporary world. Possible topics include Marxism, communism, fascism, anarchism, and the relevance of Freud to modern political thought. 3 cr.

46-250 WOMEN, POWER, AND POLITICS
An analysis of the relationship of women to power and politics especially as shown in the contemporary women's movement. 3 cr.

46-255 POLITICAL ECONOMY
The artificial boundaries between political and economic analysis are transcended as current problems in political economy are examined. 3 cr.

46-260 PUBLIC ADMINISTRATION
An introductory study of bureaucratic organization and behavior in American society. 3 cr.

46-265 STATE AND LOCAL GOVERNMENT
An exploration of the federal relationship through study of politics and government at the state and local levels. 3 cr.

46-270 LEGISLATIVE POLITICS
A comparative study of the legislative process and the law-making function focusing upon the congress, the Massachusetts state legislature and other legislative bodies. 3 cr.

46-301 RESEARCH METHODS IN POLITICAL SCIENCE
Designed to equip the student major with a comprehensive, basic repertoire of practical and academic research skills that can be applied to writing the research seminar thesis and to various possible post-graduate activities. 3 cr.

46-309 POLITICAL SOCIALIZATION IN AMERICA
An in-depth examination of the acquisition of political attitudes and values within the American political system with special emphasis upon the relationship between human rights and "schooling" for citizenship. Attention is also given to the family, peer groups, media, and elites as socializing agents for both stability and change. 3 cr.

46-311 POLITICAL OBLIGATION
An analysis of selected classical and modern theories of obligation including consensual, organic, prescriptive, and utilitarian models. Also examined are related problems and topics such as legitimacy, authority, justice, freedom, order, change, violence and civil disobedience. Consideration is given to the similarities and differences among political, legal and moral obligations. 3 cr.

46-325 ELECTORAL POLITICS
A study of voting behavior, voting patterns and critical elections with attention to causes, fluctuations and current trends. 3 cr.

46-330 POLITICAL, SOCIAL, AND TECHNOLOGICAL ALTERNATIVES
An examination of alternatives to the organization of western technological society, to include study of the values, and the political, social, and technological aspects of the alternatives analyzed. 3 cr.

46-333 TECHNOLOGY AND GENDER
An analysis of gender perspectives of technology. 3 cr.

46-342 PARTIES AND INTEREST GROUPS

Origins, characteristics and functions of American political parties and interest groups. 3 cr.

46-343 THE CONGRESS

An advanced study of the functioning of the American national congress within the American political system. 3 cr.

46-344 THE AMERICAN PRESIDENCY

An examination of the nature of the American presidency and its functioning within the American political system. Specific attention will be given to problems and the evolution of the presidency since World War I. 3 cr.

46-345 CONSTITUTIONAL LAW AND POLITICS

An advanced study of judicial review and judicial behavior as they have developed through the historical process of constitutional adjudication. Special emphasis given to the continuing tension between judicial review and American democracy. 3 cr.

46-347 CIVIL LIBERTIES LAW AND POLITICS

An advanced examination of the development of American concepts of civil liberty and equal rights through the historical process of constitutional adjudication, and in other areas of law, government and society. 3 cr.

46-350 URBAN POLITICS AND POLICY

A behavioral study of the political structures of urban areas and the major issues currently confronting them. 3 cr.

46-355 GOVERNMENT FISCAL POLICY

A review of government fiscal policy, procedures and techniques. Analysis of budget cycles, controls and decision-making processes and their impact upon public program planning and implementation. 3 cr.

46-356 PUBLIC POLICY ANALYSIS

The application of analytical techniques to the evaluation of governmental policy options. 3 cr.

46-363 POLITICS OF COMMUNIST CHINA

A study of the recent development of governmental institutions, parties, and ideology in Communist China. Emphasis is placed on the processes of nation-building in the post-World War II period. 3 cr.

46-365 SOVIET POLITICS

An examination of the relationship of politics to the functioning of Soviet society. The influence of politics upon the economy, education, family life, religion, etc. 3 cr.

46-369 MIDDLE EASTERN POLITICS

An appreciation of Middle Eastern attitudes and values will be utilized in developing insight into the tensions that exist within the Middle East and between the Middle East and the western world. Political, financial and foreign policy problems will be emphasized. Cross-listed with 43-369. 3 cr.

46-371 CARIBBEAN POLITICS

A comparative study of the political, social, cultural, and economic forces that have led to the current turmoil in the countries of the Caribbean area. 3 cr.

46-380 CONTEMPORARY AMERICAN FOREIGN POLICY

A study of the processes of American foreign policy in the contemporary world. The case study method will be used to illustrate problems of strategy and tactics in such areas as Europe, Latin America, Africa, and the Near and Far East. Cross-listed with 43-380. 3 cr.

46-382 THE VIETNAM WAR
A study of U.S. foreign policy in Indochina and the international developments resulting in U.S. involvement in Indochina after World War II. Emphasis placed on the U.S. role in the 2nd Indochina War and the intensive domestic and international repercussions. 3 cr.

46-390 DEFENSE AND DISARMAMENT
An advanced study of the international security policies currently pursued by the United States, its allies and its adversaries; evaluation and analysis of the criticism of these policies and of the possibilities of achieving disarmament. 3 cr.

Seminars

46-401 RESEARCH SEMINAR IN POLITICS
Original investigation in primary sources and secondary literature culmination in the writing of a major paper based on systematic research and methodological techniques. Weekly meetings and reports. Prerequisite: 46-301. Required course for senior political science majors. 3 cr.

46-402 20TH CENTURY REGIONAL AND INTERNATIONAL ORGANIZATION
Students will take part in a simulation of the proceedings of a regional or international organization, e.g., U.N., O.A.S., O.A.U., or the Arab League. They will study all aspects of the selected institution, but concentrate on key econimic, social and security issues discussed in the body's debates. The aim of the course is to give the students a clearer understanding of the forces and constraints which shape the foreign policies of individual states. Bergeron. 3 cr.

46-403 through 46-490 READING SEMINARS IN POLITICS
Advanced reading, discussion, analysis and research in selected areas of political study. 3 cr.

Directed Studies

Directed study courses are available only to political science majors and may be elected provided that (1) the material to be covered is not available in any course to be offered in the semester in which the directed study is taken, (2) instructors are willing to undertake a directed study course, and (3) no more than nine credits in the major field are earned in directed study courses.

46-491 DIRECTED STUDY IN POLITICAL SCIENCE
Directed study offers the student the opportunity to engage in an independent study or research project under the supervision of a department member. Working closely with the instructor, the student will define and investigate a research problem in an area of special interest and present the results of his investigation in a significant paper. Prerequisites: permission of instructor and chairperson. 3 cr.

46-495 ADVANCED TUTORIAL IN POLITICS
A program of directed study in which the advanced student develops an evaluative and critical assay. The purpose is to sharpen and refine techniques for scholarly research and presentation. This course may not be offered in place of the required seminar course. Prerequisite: demonstrated proficiency in an area selected for directed study and permission of the political science faculty and chairperson. 3 cr.

Practicum

One of the following courses is required of all political science majors.

46-496 PRACTICUM EXPERIENCE
A program of study and research (for political science majors only) stressing involvement in and first-hand knowledge and observation of the political life and relationships of national, state and local institutions. The purpose is to acquaint the student in a direct way with political institutions and political behavior. Specific requirements will vary depending upon the nature of the program undertaken by the student. The course will be graded "S" (satisfactory) or "U" (unsatisfactory). 3 cr.

46-497 PRACTICUM IN THE LAW
A program of study and research, for majors and legal studies minors only, which includes involvement in and first-hand knowledge and observation of the legal system and legal practice. The course will be graded "S" (satisfactory) or "U" (unsatisfactory). 3 cr.

DEPARTMENT OF PSYCHOLOGY

Richard Siegel, Chairperson

Professors: Janet Burke, Allie Scruggs, Mary Roth Walsh

Associate Professors: Joan Cannon, Jon Hellstedt, Kathleen Hulbert, Robert Kunzendorf, David Landrigan, Charlotte Mandell, Anne Mulvey, Ronald Pickett, Deborah Schildkraut, Richard Siegel, Linda Silka, Joseph Waterman

Assistant Professors: Charles Nikitopoulos, Gloria Seeman

The department offers a major which leads to the Bachelor of Arts degree and also offers a minor area of studies.

Psychology Major

The major in psychology is of value to students interested in human and animal behavior. It augments the general liberal arts education and provides the basis for graduate training and careers in mental health, education, research and industry. The psychology curriculum acquaints students with scientific methods and studies and with theoretical foundations in the subfields of psychology (experimental, developmental, social, personality, clinical). It also emphasizes the applications of psychological knowledge and skills in many areas of human functioning. In addition, the psychology major stresses the opportunity for advanced study in specialized areas. Students are encouraged to become involved in University and community programs and in supervised independent research. Each year the department offers special awards to graduating seniors who have made outstanding achievements in these activities.

The major in psychology consists of 33-45 credits (with at least 15 credits at the 300 course level or above) and must include the following courses;

1. Each of the following courses:
    47-101 General Psychology
    47-269 Research Methods

2. One course in each of the following four areas:
   a. Developmental Psychology
      47-261 Child Psychology
      47-262 Adolescent Psychology
      47-264 Maturity and Aging
      (Please note: 47-163, The Human Lifespan, may not be used to fulfill this area requirement and is not recommended for majors.)
   b. Social and Community Psychology
      47-209 Social Psychology
      47-255 Community Psychology
   c. Personality and Clinical Psychology
      47-232 Psychology of Personality
      47-272 Abnormal Psychology
   d. Experimental Psychology
      47-276 Theories of Learning
      47-277 Sensation and Perception
3. One Research Laboratory course from any of the following:
   47-375 Research Laboratory in Animal Psychology
   47-376 Research Laboratory in Perception Psychology
   47-377 Research Laboratory in Cognitive Psychology
   47-378 Research Laboratory in Social and Personality Psychology
   47-379 Research Laboratory in Developmental Psychology
   47-381 Research Laboratory in Human Factors Engineering
4. Two courses at the 400 level, not more than one of which may be 47-491, Directed Studies in Psychology, 47-495, Advanced Tutorial, or 47-496, Practicum in Psychology.
5. The remaining two to six courses of the major may be elected from any of the course offerings in psychology, except that at least 15 credits of the 33-45 required in the major must be at the 300 or 400 level. Human Sexuality, 83-351, may be counted towards this requirement.

Students transferring to the college and wishing to major in psychology must make individual arrangements with the chairperson of the department regarding satisfaction of major requirements.

Minor Requirements

A minor in psychology consists of 18-24 credits of course work. At least 6 credits must be taken in course work at the 300 level or above, in fulfilling the requirements for this minor area. Human Sexuality, 82-351, may count as part of minor area requirements.

Master of Arts in Community and Social Psychology

The department also offers a Master of Arts degree in Community and Social Psychology. For information regarding the objectives and requirements of this graduate program, consult the “Bulletin of Graduate Studies”.

Psychology (Course Prefix: 47)

47-101 GENERAL PSYCHOLOGY
Intended as an introductory course both for non-concentrators and for concentrators, this course surveys the major areas of psychology: the nature of psychology as a science, principles of learning, the relationship between physiological and psychological processes in humans and animals, sensation and perception, cognitive processes, motivation and emotion, personality and development, adjustment and behavior disorders, and social behavior. 3 cr.

47-163 THE HUMAN LIFESPAN
Recommended for non-concentrators, this course surveys the major theories, stages, and processes in human development from birth to death. Students who have already taken 47-261, 262, or 264 may not take this course for credit, nor may it be taken in the same semester with 47-261, 262, or 264. 3 cr.

47-209 SOCIAL PSYCHOLOGY
An introduction to the study of social behavior in interpersonal relationships, groups, organizations, and the community. Topics include attitudes and attitude change, group dynamics, interpersonal influence, and non-verbal communication. 3 cr.

47-232 PSYCHOLOGY OF PERSONALITY
An introduction to the study of human personality, including such topics as self-concept, anxiety and adjustment, achievement motivation. Psychoanalytic, humanistic, cognitive, and behavioral theories of personality are stressed with consideration of the interplay between theory and research. 3 cr.

47-255 COMMUNITY PSYCHOLOGY
A survey of the nature and practice of community psychology, including principles of community organization and change, as seen in such areas as education, mental health, corrections, and social servies. Students will participate in field research or practice under the direction of an assigned agency, and classroom work will include discussion of the field experiences of the participaants. 3 cr.

47-261 CHILD PSYCHOLOGY
An introduction to theory and research in the field of child psychology. Using a chronological approach, the course covers the concepts and processes of child development. 3 cr.

47-262 ADOLESCENT PSYCHOLOGY
An examination of developmental issues during adolescence, including personality development and the emergence of identity, peer relations, the development of moral values, and sources of maladjustment. 3 cr.

47-264 MATURITY AND AGING
An exploration of psychological development during adult years and later life, including issues of personal, family, and occupational adjustments: psychological disorders of adult life and old age; and the psychology of aging and death, with particular reference to contemporary American attitudes and practices. 3 cr.

47-269 RESEARCH METHODS
An integrated approach to methods of scientific research in psychology, including research design and the use of statistics, the interpretation of data and the role of the scientific method in psychology. 3 cr.

47-272 ABNORMAL PSYCHOLOGY
An introduction to the study of various patterns of mental, behavioral, and personality disorder, with consideration of issues of diagnosis, etiology, and treatment in terms of contemporary theory, research, and practice. Prerequisite: 47-103 3 cr.

47-275 PSYCHOLOGY OF THE HANDICAPPED
This course examines psychological and emotional aspects of such handicaps as: blindness, paralysis, degenerative diseases, mental illness, and mental retardation. The role of the family, and the societal and cultural influences which impact on the concept of illness, will be explored through reviews of current research and professional practice. 3 cr.

47-276 THEORIES OF LEARNING
This course traces the development of theories of learning from earlier global theories to more recent and more specific ones. Behavioral, cognitive and physiological approaches will be compared. Current issues of importance in the study of learning will be stressed. 3 cr.

47-277 SENSATION AND PERCEPTION
This course focuses on human sensory and perceptual capacities, and how people know the objects and events of the world through hearing, seeing, smelling, tasting, moving, and touching. In this course, students examine the bases of experiences which correspond to independent measures of the world, and the nature of illusory experiences. 3 cr.

47-278 COGNITIVE PSYCHOLOGY
This course examines the psychological bases of verbal and visual reasoning, logical and creative thought-processes, and linguistic and conceptual behaviors. The nature and limits of knowledge and creative expression are discussed. 3 cr.

47-300 COMPUTERS IN PSYCHOLOGY
An introduction to the use of computers in psychology, including data processing and analysis, simulation and gaming, and modeling of behavior. The emphasis is on practical experience with the quantitative side of psychology. Prerequisite: 47-101 or permission. 3 cr.

47-312 PRINCIPLES OF BEHAVIOR MODIFICATION
Based on the principles and findings of experimental studies of behavior, this course examines various methods and techniques suitable for the modification of human behavior, with consideration of how such methods can be used in education, mental health and corrections, and self-directed personal change. Prerequisite: 47-101, 47-276 preferred. 3 cr.

47-328 DYNAMICS OF INTERPERSONAL RELATION
An analysis of psychological dynamics in interpersonal behavior, emphasizing such topics as conformity, leadership, interpersonal growth, self-disclosure, personal styles of interaction and communication, and techniques of change. The primary focus will be on the behavior of the students themselves, who will be expected to participate in the classroom. The course is taught without a prerequisite, but is open only to juniors and seniors. 3 cr.

47-332 HISTORY OF PSYCHOLOGY
This course examines the historical roots of psychology, from the pre-scientific psychologies of the ancient Greeks, to the twentieth century schools of the introspectionists, the Gestalt psychologists, and psychoanalysts. Historical resolutions of recurring issues are contrasted with modern resolutions. Prerequisite: 47-101. 3 cr.

47-333 PSYCHOLOGY OF CONSCIOUSNESS

This course will introduce students to psychological theories and studies of the mind-body dualism, mind-brain identity, and the emergence of mind will be introduced. Studies of psychosomatic disease and healing imagery, sleep and hypnosis, "subconscious" perception and "extra sensory" perception, multiple personalities and "split brain" patients will be discussed. The questions of animal awareness and computer consciousness will also be considered. Prerequsite: 47-101 or 278. 3 cr.

47-335 PSYCHOLOGY OF WOMEN

A consideration of such topics as: the psychology of sex differences; biological bases of psychological sex differences; the nature of female sexuality; clinical theory and practice concerning women: women as mental patients and mental health consumers; implications for psychology and for women's status. Taught without prerequisite, but intended primarily for juniors and seniors. 3 cr.

47-345 PSYCHOLOGY OF HEALTH

An examination of psychological aspects of human health, both physical and mental, and the processes of adjustment and growth. Consideration will be given to the interplay of health and illness, with emphasis on psychological methods of overcoming and preventing illness and of enhancing physical and emotional well-being. Prerequisite: 47-232 or 272. 3 cr.

47-352 PSYCHOLOGICAL TESTING

A survey of major tests and techniques used to assess mental abilities, vocational interests, attitudes, and personality; an introduction to the various professional settings in which testing and assessment methods are used (e.g., mental health, rehabilitation, employment and personnel selection, criminal justice). Students learn to administer, score, and interpret specific tests, and learn how to develop a case study or report based on test data and related information. Prerequisite: 47-101. 3 cr.

47-364 PSYCHOLOGY OF CRIME AND CORRECTIONS

An investigation of the psychological aspects of crime and deviance and the nature of punishment and rehabilitation. Clinical case histories of criminal personalities will be studied in conjunction with contemporary psychological theory and research concerning anti-social and deliquent behavior. The nature of prisons and the criminal justice system, as well as the aspects of psychological services, will also be considered. Prerequisite: 47-101. 3 cr.

47-369 STATISTICS IN PSYCHOLOGY

An introduction to basic statistics used in psychology, including descriptive statistics, sampling, the normal distribution, correlation and regression, and inferential statistics (t test, chi-square, analysis of variance). Prerequisite: 47-269 or permission of instructor. 3 cr.

47-372 COMPARATIVE PSYCHOLOGY OF ANIMAL BEHAVIOR

Animal behavior will be identified and classified. The relations between behaviors of similar and different species will be subjected to a comparative analysis and examined in terms of evolutionary origin, development, conditioning, anatomical structures, and environmental influences. Methods of comparative research will be considered. Prerequisite: 47-269, or consent of instructor. 3 cr.

47-373 THE BIOLOGY OF BEHAVIOR

A survey of issues and topics dealing with the physiological and evolutionary bases of behavior. Biological systems and processes that influence behavior are considered, with particular emphasis on brain mechanisms. Recent discoveries in the neurosciences will be presented. Methods of research will be reviewed. Prerequisite: 47-269, or consent of instructor. 3 cr.

47-374 HUMAN FACTORS IN ENGINEERING AND DESIGN

Surveys the discipline of human factors and demonstrates its importance in the design of tools, equipment and systems for more effective, safe and comfortable human use. Identifies human strengths and limitations in such physical aspects as attention, perception, memory and cognition. Ways of adjusting the design of systems to exploit human strengths and circumvent limitations are illustrated. Prerequisite: 47-101, or permission. 3 cr.

Research Laboratories in Psychology

The following six courses satisfy the research laboratory requirement for the major. At least one course will be offered each semester; some will be offered more frequently than others. All six laboratory courses involve both lecture and laboratory work, and they are designed to introduce the student to the methods and principles of experimental and/or observational research.

Students will conduct their own research under supervision and will be required to submit regular laboratory reports. All Research Laboratory courses have 47-269 Research Methods as a prerequisite. Students must register for both lecture and the separate laboratory.

47-375 RESEARCH LABORATORY IN ANIMAL PSYCHOLOGY

(Previous title: Experimental Psychology: Learning) The focus of this course is on basic principles of learning and behavior, derived from animal studies. Emphasis will be on environmental and evolutionary determinants of behavior. Experimental studies using nonhuman subjects will be required. Prerequisite: 47-269; 47-276 or 277 or 278. 3 cr.

47-376 RESEARCH LABORATORY IN SENSATION-PERCEPTION

This course introduces students to research in sensation and perception. Students can gain a firm grounding in the fundamentals of psychological research through a beginning series of instructor designed laboratory projects. Students will develop skills in asking and answering questions about human capacities to experience the world and apply those skills to an original research project. Prerequisite: 47-269; 47-276 or 277 or 278. 3 cr.

47-377 RESEARCH LABORATORY IN COGNITIVE PSYCHOLOGY

This course emphasizes research into human cognitive processes: the processes of perceiving, remembering, imaging, thinking, and communicating. Students develop the skills necessary to complete original research projects on cognitive issues of their own choosing. Prerequisite: 47-269; 47-276 or 278 or 374. 3 cr.

47-378 RESEARCH LABORATORY IN SOCIAL AND PERSONALITY PSYCHOLOGY

The focus of this course is on social behavior an various aspects of personality studied within various research frameworks. This course is designed to introduce students to the experimental method as applied in social psychology and to other methods relevant to the study of individual differences. Students develop the skills necessary to complete an original research project. Prerequisite: 47-269; 47-209 or 233. 3 cr.

47-379 RESEARCH LABORATORY IN DEVELOPMENTAL PSYCHOLOGY

This course covers some of the various research techniques utilized in the study of human development over the life span (observational techniques, case studies, psychological tests and measures, field studies, quasi-experimental and experimental methods). Students develop the skills necessary to carry out original research projects on aspects of developmental psychology, under faculty supervision. Prerequisite: 47-269; 47-261 or 264. 3 cr.

47-381 RESEARCH LABORATORY IN HUMAN FACTORS

The focus is on methods for studying human technical performance at cognitive tasks like pattern recognition and decision making at psychomotor tasks like typing and operating complex equipment. Laboratory exercises will be supplemented where feasible by field visits to technical work settings. Prerequites: 47-269 or permission; 47-276 or 277 or 278 or 374. 3 cr.

Advanced Seminars

The following 400 level seminars are designed primarily for upperclass majors in psychology, and any of them may be used to satisfy the 400 level requirement (6 credits) of the concentration. They all carry prerequisites and involve a high degree of independent work in field experience and/or research. Emphasis is on current developments in specialized areas of psychology reflecting the expertise of members of the faculty. The descriptions provided below should be considered only in general terms: seminars are highly individualized and vary considerably in content and approach from one instructor to another. Each semester, the department will post notices providing more detailed descriptions, and students are urged to utilize this information in making their selections. Seminar enrollments will be strictly limited, and a high degree of student participation is expected. Each year at least one specific seminar in each of the general areas will be offered. Students may enroll for as many different seminars as they wish, including as many as two seminars in the same general area, provided that only one seminar is taken for credit in a specific topic.

47-473 SEMINAR IN SOCIAL PSYCHOLOGY

Intensive study of one or more of the following special topics in social psychology: small group interaction; social aspects of health and illness; conformity; attitude formation and prejudice; patterns of communication, including non-verbal communication; the psychology of sex roles; methods of social action and social change in the community. Prerequisites: 47-269 and 209. 3 cr.

47-474 SEMINAR IN DEVELOPMENTAL PSYCHOLOGY

Careful consideration of selected topics in the area of human development, including the following: psychology of the family and parent-child relations, infant development, adjustment during adulthood, death and dying, etc. Prerequisites: 47-269; 47-261 or 262 or 264. 3 cr.

47-475 SEMINAR IN CLINICAL PSYCHOLOGY

This seminar will focus on such topics as the following: the nature of psychotherapy and clinical practice, analysis of specific clinical theories of psychopathology and psychotherapy (transactional analysis, Gestalt, psychoanalysis), the nature and causes of specific psychological disorders (schizophrenia, affective disorders, etc.), the nature of mental hospitals, the community mental health movement, clinical methods of assessment, current topics in personality theory and research, etc. Placement may be required. Prerequisites: 47-269; 47-232 or 272. 3 cr.

47-476 SEMINAR IN EXPERIMENTAL PSYCHOLOGY

Intensive study of specific topics and areas of psychological research from among the following: the experimental analysis of behavior, sensation and perception, cognitive psychology, the biology of behavior, the comparative study of animal behavior, and other selected topics related to experimental psychology. Prerequisite: 47-269; other prerequisites may be specified by the intructor. 3 cr.

47-477 SEMINAR: CONTEMPORARY TRENDS IN PSYCHOLOGY

This seminar will be offered from time to time, and deals with issues in contemporary areas of psychological practice and/or research; implications for future developments in the field will be covered. Prerequisite: 47-269; other prerequisites may be specified by the instructor. 3 cr.

Directed Study

Directed studies are available only to psychology majors and may be elected provided that (1) the material to be covered is not available in any course offered during the semester in which a directed studies/advanced tutorial is contemplated, (2) instructors are willing to undertake the supervision of the student's work, and (3) no more than 9 credits in the major are acquired in directed studies/advanced tutorials.

Directed studies offer a student the opportunity to engage in an independent study or research project during an academic semester under the supervision of a department member. The topic for such work will be jointly determined by the student and his/her supervisor. Interested students are required to apply to the department prior to pre-registration for the semester in which they wish to enroll. This application must be on a form available from the department and will be reviewed to determine:

a. feasibility of the proposed work
b. availability of an appropriate faculty member
c. ability of the student to engage in this concentrated and sustained effort.

Students are advised to examine the list of department members and their specialized fields of interest before writing their study proposal for the application. Each student who is accepted for a directed study/advanced tutorial will be responsible for submitting a final version of the proposal to the department before the end of the Drop-Add period of the semester during which the work is undertaken. Although no prerequisites have been set, it is expected that the student will approach this study with the basic theory and the academic and technical skills essential in high level work, and ordinarily only juniors or seniors will be considered.

47-491 DIRECTED STUDY IN PSYCHOLOGY

Through frequent consultation with the instructor, the student will carry out the investigation of a particular specialized area of interest. One semester of directed studies (or one semester of practicum, but not one semester of each) may be counted toward satisfaction of the 400 level requirement of the major. 3 cr.

47-495 ADVANCED TUTORIAL IN PSYCHOLOGY

An opportunity for the student to work at the highest level of specialization and independence on a project of his or her own design. Careful consultation with the faculty is necessary. Prerequisite: 47-491. 3 cr.

Practicum

47-496 PRACTICUM IN PSYCHOLOGY

A program of practical experience for psychology majors only. Specific requirements will vary, but the practicum experience is designed to enable upperclass students to work and study in a variety of areas related to psychological practice and research (mental health agencies, hospitals, prisons, schools, University programs, etc.). Practicum may be repeated for a maximum of 9 credits. Students will be graded "satisfactory" or "unsatisfactory". The practicum experience may not be substituted for any required course in the major, but one semester of practicum (or one semester of directed studies, but not one of each) may be counted toward satisfaction of the 400 level requirement of the major. Prerequisite: permission of the department or designated faculty member, which must be obtained prior to pre-registration for the semester in which the practicum is to be taken.

Graduate Courses in Community and Social Psychology

For graduate courses in Community and Social Psychology, consult the "Bulletin of Graduate Studies".

DEPARTMENT OF SOCIOLOGY

Shirley Kolack, Chairperson

Professors: Levon Chorbajian, Mitra Das, Shirley Kolack, John MacDougall

Associate Professors: Carol Brown, Frederick Sperounis

Assistant Professors: William Harrison, Marie O'Brien, Arlene McCormack

The Department of Sociology offers a major leading to the Bachelor of Arts degree and also a minor area of studies.

Sociology Major

The major in sociology offers students the opportunity to understand the nature of social life in our own and other societies. It provides a unique perspective from which to gain a systematic view of material in a large number of different fields. Courses within the department therefore cover a wide range of fields and encompass such topics as ethnic cultures, the dynamics of social policy, relationships between sexes, the nature of industrial capitalism, and the impact of technology on modern society. Students are encouraged to do work in the Lowell area as part of the sociology program. A prevalent value within the department is the search for meaningful social change. Students who are interested in working in human services, personnel management, urban planning, elder services, communications, law, teaching or full-time academic work might consider a major in sociology.

A major in sociology consists of 30-45 credits (with at least 15 credits at the 300 or 400 levels) and must include the following:

1. 48-101 Introduction to Sociology
2. 48-321 Social Theory
3. 48-402 Sociological Research
4. One other 400 level course

Students transferring to the college and wishing to major in sociology must make individual arrangements with the department chairperson regarding satisfaction of major course requirements.

Sociology Minor

A minor area of study consists of 18-24 credits of course work in sociology. At least 6 credits must be taken in course work at the 300 level or above.

Sociology (Course Prefix: 48)

48-101 INTRODUCTION TO SOCIOLOGY
This is the basic course in sociology. Emphasis is directed at the ways in which social institutions such as government, schools, the economy, social class, and the family develop and influence our lives. It is concerned not only with presenting various ways to understand our relationship to society, but also with ways to change it. Prerequisite to all 300 and 400 level sociology courses. 3 cr.

48-110 INTRODUCTION TO SOCIAL VALUES: PATRIOTISM, RELIGION AND MOTHERHOOD

A sociological analysis of belief systems in the contemporary United States. The different perspectives held by different social groups will be shown, and students encouraged to examine their own perspectives. The role of churches, governments and families in conserving and changing the social structrue of modern society will be examined. Beliefs will be related to political and economic interests and conflicts. Historical and international comparisons will be made. Brown. 3 cr.

48-131 SOCIOLOGY THROUGH LITERATURE

Understanding the social order through the study of fiction. Emphasis is placed on contemporary fiction and students read the works of a number of Third World writers. 3 cr.

48-193 FUTURISTICS I: WHY WE STUDY THE FUTURE AND HOW

Study units cover philosophical and historical backgrounds, futurists and their ideas, resources (future file, words, etc.), forecasting, scenario construction and myth breaking, special unit on creativity. Concludes with student class projects (future food, games, etc.). Harrison. 3 cr.

48-195 FUTURISTICS II: ALTERNATIVE FUTURES

A continuation of 48-193. Harrison. 3 cr.

48-201 SOCIAL ANTHROPOLOGY

Using the comparative approach to society, this course examines several distinct cultures as a means of understanding both the universal constants and the variations in human societies. Das. 3 cr.

48-203 TECHNOLOGY AND HUMAN VALUES I

See 59-203. Staff. 3 cr.

48-204 TECHNOLOGY AND HUMAN VALUES II

See 59-204. Staff. 3 cr.

48-210 SOCIOLOGY THROUGH LITERATURE

An attempt to understand society through the study of fiction. Emphasis is placed upon contemporary literature. 3 cr.

48-212 CULTURES OF THE WORLD

This course will focus on a different country or region each time it is given. Students will examine the traditional culture, recent history, economic development, class structure and international relations of the area covered. See the department chairperson for specifics. 3 cr.

48-214 NUCLEAR WEAPONS, VALUES AND SOCIETY

An examination of popular values and conceptions concerning nuclear weapons, and of the political, diplomatic and economic issues surrounding these weapons. An analysis of the strategic and political interests of the major powers, and of alternatives to the nuclear arms race. MacDougall. 3 cr.

48-220 SELF ASSESSMENT AND CAREER DEVELOPMENT

Study of the meaning of work in our society. Class participants will assess their own life experiences, keep journals and develop a plan to integrate their interests, values and abilities into meaningful and realistic life/work patterns. Oatis and Scott. 3 cr.

48-231 SOCIOLOGY OF THE FAMILY

Study of the nature of the family in contemporary society with particular emphasis on the family in America. What functions does the family perform in modern society? How is it changing? How do these changes affect our lives? Das. 3 cr.

48-234 THE STUDY OF MINORITIES

This course examines the process of immigration and majority-minority relations in the U.S. over the last century with particular emphasis on the process of adaption in a pluralistic society. Prerequisite: 48-101. Kolack. 3 cr.

48-241 SOCIOLOGY OF WOMEN AND MEN

The women's movement has changed our accepted views of women and men. The course will seek for an understanding of the positions of women and men in culture, the economy, the family and political life. Crucial are the questions "what do we want?" and "what do we need?" Specific topics will be examined. Brown. 3 cr.

48-250 SOCIOLOGY OF NON-VIOLENCE

An analysis of non-violent efforts to achieve social change through demonstrations, civil disobedience, etc. Movements led by Mahatma Gandhi, Martin Luther King Jr., and others are examined. Das. 3 cr.

48-255 SOCIAL DEVIANCE

An analysis of behavior considered deviant, such as drug abuse, crime and mental disorders. Attention is paid to cultural definitions of deviance and to social institutions that treat people defined as deviant. O'Brien. 3 cr.

48-256 POLITICAL SOCIOLOGY

This course focuses on the development and use of power in modern society. Emphasis is placed on the relationship of American political institutions to economic institutions, to social class, and to supporting ideologies. Prerequisite: 48-101 or permission of instructor. O'Brien. 3 cr.

48-260 MASS MEDIA AND COMMUNICATIONS

This course investigates the structure of mass communications and the impact of the media on our lives. A full range of media are considered, including television, radio, cinema, and the press. The potential impact of new media sources such as cable TV are also considered. Brown. 3 cr.

48-288 INDUSTRIAL LOWELL: DECLINE AND REBIRTH

An interdisciplinary course dealing with the growth, decline and rebirth of Lowell, Massachusetts, from its inception as the first planned industrial city to the present time. This course is designed to complement the establishment of the first urban National Park in Lowell. Kolack, Das, and staff. 3cr.

48-301 SOCIOLOGY OF HUMAN RIGHTS

The course will examine the politically divergent definitions of rights and freedoms. Attention will be paid to the activities of international human rights organizations and to the human rights policies of the major powers. Various current human rights issues will be examined. Case histories may include the Soviet Union, Northern Ireland, South Africa, Afro-Americans, Armenians and Palestinians. Prerequisite: 48-101. Chorbajian. 3 cr.

48-316 SOCIOLOGY OF THE MIDDLE EAST

After a brief introduction to the history of the region, the course will focus on such 20th century themes as the defeat of the Ottoman Empire, the European colonial period, the rise of Arab nationalism, the Palestinian question, the development of modern class formations, major power rivalries, Middle Eastern minorities, and the role of women. Prerequisite: 48-101. Chorbajian. 3 cr.

48-321 SOCIAL THEORY
An examination of the most important social theorists, both historic and recent. Students will learn how theory is created, and how it is linked to facts. Prerequisite: 48-101, plus two other sociology courses. Brown, Sperounis. 3 cr.

48-323 THE SOCIOLOGY OF IDEAS AND VALUES
A consideration of the ways in which ideas and values arise in society and in turn influence social action. Included are scientific facts, myths, ideologies, religions, morals, and commonsense beliefs. Prerequisite: 48-101. 3 cr.

48-335 THE BLACK EXPERIENCE IN AMERICAN LIFE
Careful examination of the role and status of the Black in the United States since slavery. Prejudice, racism, and Black separatism are emphasized. Prerequisite: 48-101. Chorbajian. 3 cr.

48-341 SOCIAL STRATIFICATION
This course focuses on the phenomenon of social class distinctions with particular emphasis on social class in America. The approach taken is both historical and sociological. Prerequisite: 48-101. Kolack, O'Brien. 3 cr.

48-345 URBAN SOCIOLOGY
This course deals with issues related to the quality of life in American cities. Students taking this course may engage in research projects on the city of Lowell and the role of the University of Lowell within that city. Prerequisite: 48-101. Brown. 3 cr.

48-350 SOCIAL SERVICE
An examination of the structure of social welfare services in America. Attention is directed at the functions that welfare and mental health institutions serve in American society; the attitudes and values that surround these institutions; and the role of the social worker within them. Prerequisite: 48-101. 3 cr.

48-351 THE SOCIOLOGY OF HEALTH AND HEALTH CARE
A historical and contemporary study of the socio-politics of health, illness, and the health care industry in the United States. Attention is given to providers, consumers, owners, workers, and professionals in terms of their power, class, race, sex, and age. Reforms and alternatives are considered. Prerequisite: 48-101. MacDougall, McCormack. 3 cr.

48-357 THE SOCIOLOGY OF RELIGION
An investigation of religious institutions and experiences. Emphasis is placed on the influence of religion on social change. Prerequisite: 48-101. Chorbajian. 3 cr.

48-361 THE SOCIOLOGY OF LAW AND THE CRIMINAL JUSTICE SYSTEM
Introduction to the theory, structure, ideology, and practice of the criminal justice system. Particular attention is directed at the definition of crime and the impact of social, political, and economic policy on the operation of systems and their impact on its "clients". Prerequisite: 48-101. O'Brien. 3 cr.

48-371 SOCIOLOGY OF COMPUTERS AND WORK
This research course will acquaint students with the theoretical issues and research findings surrounding computer technology and the workplace. Using the case study method of investigation, students enter a workplace setting of their choice to explore issues raised in the literature. Prerequisite: 48-101. McCormack. 3 cr.

48-382 SOCIAL MOVEMENTS

This course considers organized action undertaken to alter the social position of a group. Organization, techniques of action, motivation of participants, and group ideologies are studied. Materials from historical, social, psychological, and social sources are used. Prerequisite: 48-101. Das. 3 cr.

48-383 SOCIOLOGY OF PEACE ISSUES

The world is increasingly approaching a situation where our human and material resources are being threatened by such global problems as abuses of human rights, world hunger, racism, and ecological threats. All of these spell danger for our well-being now and in the future. This course addresses itself to these problems. It studies the creation of greater consciousness, responsibility and social concern for world peace and social justice. Prerequisite: 48-101. Das. 3 cr.

48-388 SEMINAR ON INDUSTRIAL LOWELL

The seminal will analyze and discuss the growth, decline and rebirth of Lowell, Mass. Special attention will be given to shifts in technology and changes in work relationships, e.g., from farm women to immigrant labor force to high technology. Lowell's rich past and present will observed first-hand by using the city as a laboratory. Prerequisite: 48-101. Kolack. 3 cr.

Advanced Courses

The following courses are intended primarily for upperclass majors. Students should have a minimum of four previous courses in sociology, including 48-101, before enrolling in these classes. Contact department chairperson or instructor for more information.

48-402 SOCIOLOGICAL RESEARCH

This course demystifies statistics and computers by familiarizing students with both the statistics commonly used in social investigation and computer software specifically designed to handle social science data. Both are used within the context of social investigation. McCormack. 3 cr.

48-404 FIELD PLACEMENT

This course provides students with the opportunity to directly observe and participate in the operation of a social service organization. Prerequisite: 48-350, and permission of instructor. 3 cr.

48-421 SEMINAR ON THE FAMILY

Study of the family structures and gender roles in various human societies. Prerequisite: 48-101 plus either 48-231 or 48-241. Brown, Das. 3 cr.

48-450 SEMINAR ON WAR AND PEACE

A research seminar on the social, cultural, political and economic aspects of war and peace. Special emphasis placed on ways to make and maintain peace in the world and particular regions. Prerequisite: permission of the instructor. MacDougall. 3 cr.

48-465 SEMINAR IN THE SOCIOLOGY OF HEALTH AND HEALTH CARE

Seminar that focuses on particular topics of interest to students and the instructor such as health, health care, government policy; prison health, nursing homes; the health industry, medical professions; health and health in other countries; and psychiatry and health. Prerequisite: permission of instructor. MacDougall, McCormack. 3 cr.

48-466 SEMINAR IN CLASS, STATUS AND POWER

Emphasizes the impact of class, status, and power relationships on the social organization of past and present societies. Special attention is focused on processes for redistributing privileges and rewards in society. Prerequisite: 48-341, 256, or permission of instructor. Kolack. 3 cr.

48-468 SELECTED TOPICS

This seminar will concentrate on a different area of sociology each time it is taught. See department for more information. 3 cr.

48-479 SENIOR SEMINAR

The class will read and analyze books on a variety of subjects. Prerequisite: permission of instructor. Brown. 3 cr.

48-484 INDUSTRY INTERNSHIP

Open to all majors in liberal arts. Practical experience of work using liberal arts skills in private industry and/or using high technology. Prerequisite: permission of instructor. MacDougall. 3 cr.

48-485 INDUSTRY INTERNSHIP II

A continuation of 48-484. MacDougall. 3 cr.

Directed Studies

Directed study courses are available only to majors in sociology and may be taken provided that (1) the material to be covered is not available in any course offered during the semester in which a directed study course is contemplated, (2) instructors are willing to undertake a directed study course, and (3) no more than 9 credits in the major field are acquired in directed study courses.

48-491 DIRECTED STUDIES IN SOCIOLOGY

The student, through regular and frequent consultation with his instructor, develops a course of directed reading in sociology and defines a problem for individual research. Prerequisite: permission of instructor. 3 cr.

48-495 ADVANCED TUTORIAL IN SOCIOLOGY

A program of directed study which affords the advanced student with an additional opportunity to pursue a previously explored problem in greater depth or to initiate an additional problem. The purpose is to sharpen and refine techniques for scholarly research and presentation in the student's major discipline. Prerequisite: demonstrated proficiency in an area selected for directed study and permission of instructor. 3 cr.

Practicum

48-496 PRACTICUM EXPERIENCE

A program of on-campus and/or off-campus experience for sociology majors only. Specific requirements will vary, depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a community, social, cultural, or artistic area and for applying techniques of problem solving and/or skills which are appropriate to the student's major discipline. May be repeated to a maximum of 9 credits. Students will be graded "satisfactory" and "unsatisfactory". The practicum experiences may not be substituted for a required course in the major. Prerequisite: permission of chairperson. 3 cr.

INTERDISCIPLINARY PROGRAMS AND MINORS

Classical Civilization

Course work for a minor area of study in classical civilization is selected in consultation with Dr. Christos Bentas of the history department from the following disciplines: art, classics, English, history, Greek, Latin, philosophy, and western cultural heritage. Course work for the classical civilization minor must be distributed in three areas with at least 9 hours in one area, 6 hours in a second area, and 3 hours in a third area. Although courses in Latin or Greek are not required for the minor, students are urged to complete at least 6 hours of the minor in a classical language at the intermediate level. At least 6 hours must be taken in course work at the 300 level or above.

Cognitive Science

A minor in cognitive science is designed primarily for the electrical engineering or computer science student who is interested in artificial intelligence. This interdisciplinary minor exposes the student to three methods of studying mental processes: philosophic and linguistic analysis, psychological experimentation, and computer simulation. Courses in each of these three areas of study are listed below. The minor consists of 18-24 credits: at least 6 credits from each area and at least 6 credits at the 300 level or higher. Technical electives and approved electives may be used to fulfill the area C requirement. Core courses in area A or area B may be applied both to the university core requirement and to the cognitive science minor. Some prerequisites for the following courses in the cognitive science minor may be waived, with consent of the instructor.

A. Philosophic and Linguistic Analyses of Cognition:
   42-308 Analysis of Modern English
   42-431 Contemporary Linguistic Theory
   45-285 Philosophy of the Creative Imagination
   45-301 Theory of Knowledge
   45-305 Language, Signs, and Symbols
   45-311 Philosophy of Mind
   45-312 Philosophy of Science

B. Psychological Experimentation on Cognition:
   47-276 Theories of Learning
   47-277 Sensation and Perception
   47-278 Cognitive Psychology of Language and Thinking
   47-376 Research Lab in Experimental Psychology: Sensation and Perception
   47-377 Research Lab in Experimental Psychology: Cognitive Psychology
   47-378 Research Lab in Social Behavior
   47-477 Seminar: Contemporary Trends/Cognition

C. Computer Simulations of Cognition:
   16-521 Automata Studies
   92-459 Artificial Intelligence
   92-465 Formal Languages
   92-466 Theory of Computation

Course work in the minor in cognitive science is selected in consultation with Dr. Robert Kunzendorf of the Psychology Department.

Latin American Studies

Courses for a minor field in Latin American studies are selected in consultation with Professor George Luter of the history department from the list below. Six credits at the 200 level or above are required for the Spanish language component. Course work for the Latin American Studies minor must meet the following distribution requirement:

Spanish Language	6 credits
History/Economics	6-9 credits
Latin American Literature	6-9 credits

At least 6 hours in non-language courses must be taken in course work at the 300 level or above.

43-205 Pre-Colombian America
43-206 Latin American Civilization
43-312 Modern Latin America
64-319 Topics in Latin American Economics
54-211 Intermediate Conversational Spanish I
54-212 Intermediate Conversational Spanish II
54-222 Reading and Conversing in Spanish I
54-223 Reading and Conversing in Spanish II

Other appropriate Spanish language courses may be substituted with the approval of the coordinator, including:

54-302 Introduction to Latin American Literature
54-401 Selected Authors (Latin America)
54-412 The Short Story in Latin America
54-416 The Latin American Novel

Students majoring in Spanish or Modern Languages (with Spanish option) may elect the Latin American studies minor, but may not offer any course in Spanish language or literature (prefix: 54-) as part of the 18-24 semester credits.

Legal Studies

The legal studies minor is an interdisciplinary minor program sponsored by the Political Science Department in conjunction with the Departments of History, Sociology, Psychology and Criminal Justice. It is designed to give the pre-law student and other students interested in the role of law in human societies a focused exposure to the subject. The minor may be elected by any student except criminal justice majors who will take many of its component courses as part of their major program. The requirements for the legal studies minor are 18-24 credits from the courses listed below with at least six credits at the 300 level or higher. Students may take courses listed below from their major program and designate them for the legal studies minor, provided that the total number of credits in the major field which a student offers towards the one hundred twenty credit minimum required for graduation may still not exceed forty-five. The Practicum in the Law, Reading Seminar in Legal Studies and Research Seminar in Legal Studies may be elected only with prior permission of the instructor. Other courses appropriate for inclusion in the legal studies minor may be designated from time to time.

46-230 Law and the Legal System
46-345 Constitutional Law
46-347 Civil Liberties Law
43-308 History of Crime and Social Control
48-361 Sociology of Law
47-364 Psychology of Crime and Corrections
44-234 Criminal Law
44-335 Juvenile Court
44-360 Minorities and the Criminal Justice System
46-403 Reading Seminar in Legal Studies
46-401 Research Seminar in Legal Studies
46-497 Practicum in the Law
44-331 Penal Law

Elective Concentration in Business Skills

The elective concentration described below is NOT a minor area of study. It is a sequence of courses designed to provide an appropriate background for liberal arts graduates who desire either to enroll in a graduate program leading to a Master of Business Administration (MBA) degree or to enter directly into business or industry on the completion of their undergraduate study. The program is designed to emphasize skills and course background that are required by MBA degree programs and that are most sought after by employers in business and industry. Students who elect this option are strongly advised to complete the program (24 credits) as specified.

92-121 Pre-Calculus Mathematics
92-122 Differential Calculus
92-201 Integral Calculus
92-242 BASIC Programming with Business Applications
64-201 Economics I (Microeconomics)
64-202 Economics II (Macroeconomics)
64-211 Statistics for Business and Economics I
64-212 Statistics for Business and Economics II

Technology, Society, and Human Values

Judith Pastore (English) Coordinator

Faculty Professors: Jack Apfelbaum (Industrial Technology), Gilbert Brown (Mechanical and Energy Engineering), Shirley Kolack (Sociology), Anthony Luizzi (Physics), John MacDougall (Sociology), James Phelps (Mechanical and Energy Engineering), Joan Rothschild (Political Science), Karl Sladek(Chemical Engineering).

Associate Professors: Carol Brown (Sociology), Mitra Das (Sociology), Jonathan Liebowitz (History), Judith Pastore (English).

The courses offered in this program are interdisciplinary in their content and structure and are designed to explore a topic in greater depth and from broader perspectives than is ordinarily possible in other courses. Many courses are team-taught by faculty chosen from various academic departments and colleges within the University. Courses emphasize the sources (scientific, philosophical, and historical) of the period studied and the interrelationship of technology and human values.

A minor in technology, society, and human values consists of 18-24 credits of course work. At least 6 credits must be selected from courses which are numbered 300 and above. With the approval of the coordinator, related courses, other than those specifically listed below, may be offered to satisfy the minor.

Technology, Society and Human Values (Course Prefix: 59)

59-203 TECHNOLOGY AND HUMAN VALUES I

This is a team-taught course about the interrelationship of technology and human values. It begins with an exploration of the industrial revolution in Lowell, followed by an examination of topics drawn from areas such as agriculture, third world development, population control, energy and natural resources, household technology, and transportation. Unifying themes are the values associated with science and technology, the role and responsibility of the scientist and technologist, and the question of whether scientific and technological development should be and can be controlled. Staff. 3 cr.

59-204 TECHNOLOGY AND HUMAN VALUES II

A continuation of 59-203. Staff. 3 cr.

59-214 NUCLEAR WEAPONS, VALUES AND SOCIETY

An examination of popular values and conceptions concerning nuclear weapons, and of the political, diplomatic and economic issues surrounding those weapons. An analysis of the strategic and political interests of the major powers, and of alternatives to the nuclear arms race. MacDougall. 3 cr.

59-215 COMPUTERS IN SOCIETY

An exploration of the relationship between computers and the society in which they operate: the nature of computers and their historical development; possibilities and problems arising from computer use in such areas of contemporary life as education, the military, and business; the issues of freedom vs. control of the individual. Liebowitz. 3 cr.

59-229 LITERATURE ON TECHNOLOGY AND HUMAN VALUES

An examination of nineteenth and twentieth century literature to understand what the impact of modern technology has been on the development of ethical values. Possible readings include Huxley, *Brave New World;* Vonnegut, *Player Piano;* Asimov, *I, Robot;* Shelley, *Frankenstein;* Kosinski, *Being There;* Didion, *Slouching Towards Bethlehem;* Stanislaw Lem, *The Cybeniad;* Zamyatim, *We;* and DeLillo, *White Noise.* Pastore. 3 cr.

59-288 SEMINAR IN INDUSTRIAL LOWELL

An interdisciplinary course dealing with the growth, decline and rebirth of Lowell, Massachusetts, from its inception as the first planned industrial city to present time. This course is designed to complement the establishment of the first Urban National Park in Lowell. Kolack. 3 cr.

59-309 THE ENGINEER IN SOCIETY

The class will examine from an interdisciplinary perspective the role of the engineer in society. How has this role changed? What can be expected for the future? The engineering personality, engineers in industry, ethics and engineering are some of the subjects to be covered. The format of the class will encourage discussion of the issues. Each student will prepare a substantial report on a topic of personal interest. Apfelbaum, G. Brown, Liebowitz. 3 cr.

59-330 POLITICAL, SOCIAL, AND TECHNOLOGICAL ALTERNATIVES

An examination of alternatives to the organization and dominant values of Western-technological society, exploring work, political systems, family, and technological change. Rothschild. 3 cr.

59-333 TECHNOLOGY AND GENDER
An analysis of gender perspectives of technology, focusing on invention, work, values, and new technologies. Rothschild. 3 cr.

59-350 SEMINAR IN TECHNOLOGY AND HUMAN VALUES
Intensive study of selected topics. Staff. 3 cr.

59-420 PROJECT IN TECHNOLOGY AND HUMAN VALUES
Student projects involving technology, society and human values. Staff. 3 cr.

59-501 ADVANCED SEMINAR IN TECHNOLOGY AND HUMAN VALUES
Intensive study on the graduate level of selected topics in technology, society and human values. Staff. 3 cr.

Western Cultural Heritage

Veda Cobb-Stevens (Philosophy), Coordinator

Faculty Professors: Mario Aste (Languages), Liana Cheney (Art), Veda Cobb-Stevens (Philosophy), Joseph Garreau (Languages), Roger Wiehe (English), Joseph Zaitchick (English).

Associate Professors: Donald Berry (English), Peter Blewett (History), Richard Derry (History), Mary Kramer (English), Clifford Lewis (English).

The interdisciplinary minor in western cultural heritage consists of 18-24 credits of course work. At least 6 credits must be selected from courses which are numbered 300 or above.

The courses offered in this program are interdisciplinary in their content and structure and are designed to explore a topic in greater depth and from broader perspectives than is ordinarily possible in other courses. Many courses are team taught by faculty chosen from various academic departments and colleges within the University. Courses emphasize the sources (artistic, literary, philosophical, and historical) of the period studied and focus on the aspirations and achievements of our own civilization.

Western Cultural Heritage (Course Prefix: 59)

59-205 HUMAN VALUES IN WESTERN CULTURE I
This course is designed to address some of the important questions of human existence through a close study of representative literary, philosophical, and religious texts from ancient times to the present, and relevant modern works in the behavioral and political sciences. In the first semester the students explore and evaluate three perennial themes: the problem of evil, self and society, freedom and fate. In the second semester course, the thematic units are: the pursuit of knowledge, the nature of humankind, and the experience of love. WCH Faculty. 3 cr.

59-206 HUMAN VALUES IN WESTERN CULTURE II
A continuation of 59-205. May be taken independently of 59-205. WCH Faculty. 3 cr.

59-208 WESTERN CULTURAL HERITAGE I
The actual development of a culture proceeds on many levels at once; the art, literature, philosophy and social structure of a given historical period evolve together, interact with one another, and eventually give rise to a new era. These courses are designed to capture the richness of the various periods of western civilization, to discern networks of dependency

and influence among the diverse aspects of epoch's culture and to trace lines of continuity between one age and another. The first semester will treat the period from ancient civilization to the Protestant reformation; the second semester will focus on developments from the seventeenth through the twentieth centuries. WCH Faculty. 3 cr.

59-209 WESTERN CULTURAL HERITAGE II

A continuation of 59-208. May be taken independently of Western Cultural Heritage I. WCH Faculty.

59-248 VALUES IN AMERICAN CULTURE

This course will examine the relationship among American views on humanity, nature and democracy, and will show how these relationships affect attitudes towards the individual, the "American Dream", science and technology. Readings will be selected from authors as diverse as the Puritans, the ex-slave Douglass, Wharton, Hemingway and Oppenheimer, and will include such genres as the essay, the short story, autobiography and the magazine article. Topics to be considered include immigration, technological invention, and the modern application of democratic principles to the business community. The course intends to show how an evolving system of values in America is a factor influencing both individual and national decisions. Lewis. 3 cr.

59-310 THE CULTURE OF ANCIENT GREECE

No one term can capture completely the richness of Greek culture, but there is one which comes closer than any other: TO KALON, which means nobility, goodness, or beauty. Taking this term as a guideline, we will explore the many facets of Greek culture by focusing upon social and political structures, the development of moral consciousness, and the appreciation of beauty. These issues will be approached through the examination of developments in Greek art as well as through reflection upon works by Greek poets, dramatists, philosophers and historians. Blewett, Cheney, Cobb-Stevens. 3 cr.

59-311 WOMEN AND THE BIBLICAL TRADITION

This course will focus primarily on the position of women as delineated in the Bible, although later works of art, philosophy and literature will be considered insofar as they constitute part of the continuing biblical tradition. Readings from the bible will also be supplemented by recent feminist interpretations which open new avenues of critique as well as appreciation of biblical texts. After a discussion of the dominant stereotypes for women in biblical tradition (Eve and Mary), there will follow an examination of such topics as women in Judaic law, notable biblical women (e.g., Deborah, Ruth, Esther), and women in the Gospels and the Pauline letters; the life, work, and thought of later Jewish and Christian women. Cobb-Stevens. 3 cr.

59-314 SOCIETY AND CULTURE IN THE EARLY MIDDLE AGES

This course will explore the political, social and cultural transformation which took place in Europe during the five centuries following the collapse of the western Roman Empire. Drawing from historical, literary, linguistic and artistic sources, the classes and lectures will focus on the classical, Christian, Germanic and Celtic contributions to the new society and culture that was being created in Europe at this time. A major aim of the course is to make the students aware of how this formative period of the early Middle Ages can help us understand the full achievements of medieval society and culture at its zenith and, ultimately, the European civilization to which it gave birth. Aste, Derry. 3 cr.

59-315 ISLAMIC CULTURE AND MEDIEVAL EUROPE

The aim of this course is to help the student to understand the major tenets of Islamic culture, and to analyze their growth and dissemination in the Mediterranean basin. Particular attention will be given to relations of Islamic culture to medieval Europe by means of the Moorish civilizations of Spain and, to a lesser extent, of Sicily. Aste. 3 cr.

59-320 SIXTEENTH CENTURY ITALIAN CULTURE

This course examines the literary, artistic and musical works of the Italian Renaissance in the sixteenth century, focusing on the theories governing the creation of these works, their backgrounds in classicism, their inter-relationship as a part of the humanistic movement, changes in modes of representation and the emergence of new genres. Attention will be given to the socio-historical conditions leading to the ideal of "universality", to the role of the Italian courts and academies in fostering the arts, and to the historical development of the Reformation and counter-Reformation. Cheney, Wiehe. 3 cr.

59-330 SEVENTEENTH CENTURY EUROPEAN CULTURE

The theme of this course will be: views of the individual and the emergence of the modern state. Concentrating primarily on France, England and the Netherlands, the course will examine both the political and social organizations of these emergent nations, as well as the various views of human nature which are expressed in their literature, philosophy and art. One of the principal goals of the course is to discern how the art forms and ideas of individuals influence and are influenced by the social and political structures around them. Blewett, Cheney, Cobb-Stevens. 3 cr.

59-375 THE IDEA OF CIVILIZATION

The course will focus on various readings ranging from the Ancient Near East to contemporary culture, such as Herodotus' *Histories, The Bible,* travelogues and diaries from the age of exploration, Gibbon's *Decline and Fall of the Roman Empire,* Conrad's *Heart of Darkness,* Mead's *Coming of Age in Samoa,* and Freud's *Civilization and its Discontents*. Students will analyze and discuss the readings in order to relfect on such questions as: How and under what conditions does a group come to think of itself as "civilized" and to consider other groups as "savage" or "barbarous"? What are the roots of prejudice (e.g., racism, sexism) and how is prejudice related to a group's self-identity? What is the relation between a civilization and the city? Civilization and the countryside or the world of nature? Do civilizations develop in cycles? Is there a consistent and repeatable pattern in the development of civilizations? Are there certain categories of self-conceptualization which appear again and again from one culture to another? If so, why? WCH Faculty. 3 cr.

Women's Studies

Veda Cobb-Stevens (Philosophy) Coordinator

Faculty: Harald Bakken (History), Mary Blewett (History), Carol Brown (Sociology), Liana Cheney (Art), Veda Cobb-Stevens (Philosophy), Mitra Das (Sociology), Alma Espinosa (Music), Curtis Hinckley (Biology), Ethel Kamien (Biology), Marianne Knowlton (English), Jonathan Liebowitz (History), Martha McGowan (English), Barbara Miliaras (English), Anne Mulvey (Psychology), Judith Pastore (English), Joan Rothschild (Political Science), Mary Roth Walsh (Psychology)

A minor in women's studies consists of 18-24 credits in cross-cultural multidisciplinary courses, six credits of which must be at the 300 level or above. Women's studies affords an opportunity to develop an understanding of issues specific to the status and condition of women and to learn how the broad range of feminist scholarship provides critical tools for transformed understanding of the disciplines, human behavior, and social institutions. The following courses are approved for the minor in women's studies. Descriptions are found under the appropriate department listing.

42-240	Literature and Women
42-241	Women in Film
42-242	The Heroine in Modern Fiction 42-243 Contemporary Women Writers
42-345	Female English Novelists
43-268	History of the Family and Childhood in the United States
43-270	Women in American History
43-274	The Family in Western Society
43-307	Work and Society
45-360	Feminist Philosophy and the Question of Values
45-405	Seminar in Feminist Theory
46-250	Women, Power and Politics
47-335	Psychology and Women
47-473	Seminar: Social Psychology*
47-477	Seminar: Contemporary Trends*
47-523	Women in the Community (graduate level)
48-231	Sociology of the Family
48-241	Sociology of Women and Men
48-421	Seminar on the Family
58-340	Women and Art
59-311	Women and the Biblical Tradition
59-333	Technology and Gender
74-166	Women in Music
82-351	Human Sexuality

* When a special topics course is relevant to women's studies

Additonal courses that include considerable material on gender issues may also be approved for the minor, upon application to the coordinator and steering committee. Examples of such courses are the following:

45-281	Symbols and Society
46-330	Political, Social, and Technological Alternatives
48-110	Introduction to Social Values: Patriotism, Religion, and Motherhood
59-208/9	Western Cultural Heritage I & II

FACULTY OF THE COLLEGE OF LIBERAL ARTS

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Richard L. Derry, A.B.; A.M.; Assistant Dean

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Mitra Das, A.B.; A.M.; Ph.D.; Sociology
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PROGRAM DIRECTORS

Charles F. Carroll, A.B.; A.M.; Ph.D.; Coordinator, American Studies
Joyce Denning, A.B.; A.M.; Director, Second Chance Program

RESIDENT FACULTY

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Mario Aste, Professor, Languages; A.B., University of Turin; A.M., Ph.D., Catholic University

Harald C. Bakken, Associate Professor, History; A.B., University of Minnesota; A.M., Ph.D., Harvard University

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Mary Blewett, Professor, History; A.B., A.M., Ph.D., University of Missouri

Peter Blewett, Associate Professor, History; A.B., Northeastern University; A.M., Ph.D., Boston College

Robert Bousquet, Associate Professor, French; A.B., M.Mus., Catholic University Ph.D., Georgetown University

Carol Brown, Associate Professor, Sociology; A.B., Bucknell University; M.A., Ph.D., Columbia University

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Robert J. DeYoung, Associate Professor, English; A.B., M.A., New York University

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Frederic L. Faudie, Professor, Art; A.B., Cornell University; A.M., University of Iowa, M.F.A., Syracuse University

Robert J. Foy, Professor, English; B.S., Plymouth State College of U.N.H.; M.A., Ed.S., George Peabody College; Ed.M., Ed.D., Harvard University

Arthur Friedman, Associate Professor, English; A.B., City College of New York; A.M., Boston University

Joseph Garreau, Professor, French; A.B., University of Poitiers; S.T.L., College Saint-Albert de Louvain; A.M., Ph.D., Boston College

June Gonsalves, Associate Professor, Criminal Justice; A.B., J.D., Northeastern University

Robert Griffin, Assistant Professor, English; B.S., Salem State College; M.A., Tufts University

Robert Griffith, Associate Professor, Art; B.S.Ed., Mass. College of Art; M.F.A., Pratt Institute

William Harrison, Assistant Professor, Sociology; A.B., Harvard University

Jon C. Hellstedt, Associate Professor, Psychology; A.B., Augustana College; B.D., Yale University; Ph.D., Boston University

J. Heli Hernandez, Associate Professor, Spanish; A.B., University of Javeriana (Bogota); A.M., Ph.D., Catholis University

William R. Hersey, Associate Professor, English; B.S., Lowell State College; M.A., Boston College; Ph.D., University of New Hampshire

Gerald T. Hotaling, Assistant Professor, Criminal Justice; B.A., University of Delaware; M.A., Ph.D., University of New Hampshire

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Mary D. Kramer, Associate Professor, English; A.B., University of Wisconsin; A.M., Ph.D., University of Kansas

Robert Kunzendorf, Associate Professor, Psychology; A.B., Yale University; M.A., University of Virginia

David A. Landman, Assistant Professor, English; A.B., New York University; A.M., Boston University

David Landrigan, Associate Professor, Psychology; B.S., Tufts University; M.A., Ph.D., University of New Hampshire

Clifford L. Lewis, Associate Professor, American Studies and English; A.B., Union College; A.M., SUNY, Buffalo; Ph.D., University of Texas

Frederick P. Lewis, Professor, Political Science; A.B., Colombia College; J.D., Harvard University; Ph.D., Tufts University

Jonathan J. Liebowitz, Associate Professor, History; A.B., Colombia University; M.A., Ph.D., University of California at Berkeley

Alan Lincoln, Professor, Criminal Justice; B.S., Michigan State; M.S., M.A., Ph.D., University of Massachusetts

William A. Lindeke, Assistant Professor, Political Science; A.B., M.A., San Diego State College; Ph.D., Claremont Graduate School

Joseph W. Lipchitz, Professor, History; A.B.,M.A., University of Massachusetts; Ph.D., Case Western Reserve University

George W. Luter, Associate Professor, History; B.S., A.M., Xavier University

John MacDougall, Professor, Sociology; A.B., Oxford University; Ph.D., Harvard University

Charlotte Mandell, Associate Professor, Psychology, A.B., Brooklyn College; M.A., Ph.D., Columbia University

Donald J. Mattheisen, Associate Professor, History; A.B., A.M., Ph.D., University of Minnesota

John M. McCaffrey, Assistant Professor, English; A.B., Suffolk University; A.M., Tufts University

Arlene McCormack, Assistant Professor, Sociology; A.B., M.A., Ph.D., Boston University

Martha McGowan, Associate Professor, English; A.B., Brandeis University; A.M., Boston College; Ph.D., Boston University

Eugene Mellican, Assistant Professor, Philosophy; A.B., M.A., Ph.D., Loyola University

Barbara Miliaras, Associate Professor, English; A.B., Ed.M., Boston University

Arthur Miller, Professor, History and Philosophy; B.S., City College of New York; Ph.D., Massachusetts Institute of Technology

Arno R. Minkkinen, Associate Professor, Art; B.A., Wagner College; M.F.A., Rhode Island School of Design

Avalon N. Minton, Assistant Professor, Political Science; A.B., Wake Forest University

Howard K. Moore, Professor Emeritus, English; A.B., A.M., Boston University; M.L.S., Simmons College; Ph.D., Boston University

Anne Mulvey, Associate Professor, Psychology; A.B., Barat College; M.A., Hunter College;Ph.D., City University of New York

Charles Nikitopoulos, Assistant Professor, Psychology; A.B., Suffolk University A.M., New School for Social Research; Ph.D., Boston College

Marie O'Brien, Assistant Professor, Sociology; B.S., M.A., Ph.D., Boston University

Gerald W. O'Connor, Professor, English; A.B., Harvard University; A.M., Ph.D., Boston University

Judith Pastore, Associate Professor, English; A.B., Rutgers University; A.M., Radcliffe College; Ph.D., Harvard University

Melissa M. Pennell, Assistant Professor, English; A.B., College of William and Mary; A.M., Ph.D., Brown University

Hai B. Pho, Associate Professor, Political Science; A.B., Boston College; A.M., Rutgers University; A.M., Ph.D., Boston University

Ronald Pickett, Associate Professor, Psychology; A.B., Dartmouth; M.A., Ph.D., University of Michigan

Brenda Pinardi, Professor, Art; B.S.Ed., Massachusetts College of Art; M.F.A., Rhode Island College of Design

Christine F. Rideout, Assistant Professor, Political Science; A.B., Smith College; A.M., Columbia University; Ph.D, Massachusetts Institute of Technology

William H. Roberts, Professor, English; A.B., B.S., A.M., Ph.D., Ohio State University

Joan A. Rothschild, Professor, Political Science; A.B., Cornell University; M.A., Ph.D., New York University

Charles J. Ryan, Assistant Professor, English; A.B., University of Connecticut; M.A., University of Massachusetts

Joseph F. Ryan, Assistant Professor, English; A.B., Notre Dame University; Ph.D., University of Chicago

Herlinda Ch. Saitz, Assistant Professor, Spanish; Licenciatura, University of Panama; Diplomas de Especializacion, Semanario Andres Bello, Colombia; Ph.D., Boston University

Deborah Schildkraut, Associate Professor, Psychology; A.B., Chatham College; M.S., Ph.D., University of Miami

Allie Scruggs, Professor, Psychology; B.S., Ed.M., Ed.D., Boston University; C.A.G.S., Harvard University

Gloria C. Seeman, Assistant Professor, Psychology; A.B., City College of New York; M.S., Ph.D., Syracuse University

John J. Shea, Associate Professor, History; A.B., Harvard College; A.M., Creighton University; Ph.D., Boston University

Richard A. Siegel, Associate Professor, Psychology: A.B., Harvard College; M.S., Yale University; Ph.D., Boston University

Linda Silka, Associate Professor, Psychology; B.S., Oklahoma University; M.A., Ph.D., Kansas University

P. Christopher Smith, Professor, Philosophy; A.B., A.M., Columbia University; Ph.D., University of Heidelburg

Frederick Sperounis, Assistant Professor, Sociology; B.S.Ed., Salem State College; M.A., Ph.D., Brandeis University

John Staulo, Associate Professor, Languages; A.B., Boston College; M.A., Middlebury College; Ph.D., Catholic University of America

Robert A. Stein, Professor, English; A.B., Clark University; A.M., Ph.D., Brandeis University

Francesca Tillona, Associate Professor, English; A.B., Brooklyn College; A.M., Ph.D., Boston University

Gardner Tillson, Associate Professor, English; A.B., Tufts University; A.M., Pennsylvania State University

Anthony C. Turrisi, Assistant Professor, English; B.S., Massachusetts Institute of Technology; M.A., University of Wisconsin

James W. Veatch, Assistant Professor, Art; B.S., State University of New York, Brockport; M.F.A., Rochester Institute of Technology

Robert B. Wagner, Associate Professor, Philosophy; B.S., Ohio State University; A.M., Kent State University; Ed.D., Harvard University

Francis R. Walsh, Professor, History; B.S., M.A., Ph.D., Boston University

Mary Roth Walsh, Professor, American Studies and Psychology; B.S., Mount Mary College; M.S., Cornell University; Ph.D., Boston University

Joseph W. Waterman, Associate Professor, Psychology; B.S., University of Vermont; M.B.A., Boston University; Professional Diploma, (Guidance), University of Connecticut

Robert J. Whelan, Assistant Professor, German; A.B., Boston College; M.A., Catholic University of America

Robert E. Wiehe, Professor, English; A.B., Yale University; M.A., University of Illinois; Ph.D., Colombia University

Joseph Zaitchik, Professor, English; A.B., Suffolk University; A.M., Ph.D., Boston University

Charles E. Ziavras, Professor, English; B.S., M.A., Boston University

COLLEGE OF PURE AND APPLIED SCIENCES

Arthur C. Watterson, Acting Dean
F. Raymond Hardy, Assistant Dean

Motivation for the pursuit of scientific and mathematical inquiry stems from two basic human characteristics. One is the quest for knowledge for its own sake in order to understand the workings of our universe, and the other is the desire to enlist the investigative techniques of science and mathematics in the service of humanity in order to improve the quality of life. These two aspects of science, one of which allows us to properly define the energies and matter of our reality and the other of which is applied to the task of freeing our lives from disease and deprivation, are integrated and harmonious activities – although from time to time the relative emphasis placed by society on each activity may change. Until the Industrial Revolution, the cultural side of science was in the ascendence. Since this time, a greater societal awareness has been placed on the practical application of the scientific discovery process, and during the past century science has so enriched our lives that it is difficult to conceive of a truly educated person who has not had exposure to some of the concepts and methodologies of science.

Undergraduate programs in the pure and applied sciences serve the pre-professional needs of students who desire to enter such fields as medicine and provide excellent preparation for graduate studies in the several pure and applied sciences as well as for science-oriented careers in business, government, and industry. Regardless of the student's career goals, however, the program of study which an individual may elect should have universal perspective and significance as well as particular depth and comprehension. It should provide experiences for developing competency in using the modes of thought characteristic of the major areas of scientific knowledge as well as providing the opportunity for developing a thorough understanding of at least one scientific area. To the degree that undergraduate education in the pure and applied sciences is the basis for further graduate training, for career preparation, or for the meaningful perception, integration, and understanding of life experiences, it must be both general and specific and must be determined not only by such personal considerations as individual interests, demands, and competencies but also by such impersonal factors as the spectrum of scientific knowledge and the nature of particular scientific disciplines.

OBJECTIVES OF THE COLLEGE OF PURE AND APPLIED SCIENCES

The educational objectives of the College of Pure and Applied Sciences are to contribute to the advancement of science, to provide support and service courses for non-science majors, to provide the basic understanding of scientific concepts and methodologies which is an essential ingredient of a liberal education, and to prepare students for entry into the various science-related professions.

The curricula of the college seek to increase the capacities of students who major in the pure and applied sciences for understanding themselves and the world in which they live, especially as these capacities relate to the modes of thought which are characteristic of the major areas of scientific knowledge. To accomplish this objective, the several curricula are organized to foster fundamental communication skills in language and mathematics, to promote appreciation and comprehension of man's cultural, social, physical, and biological environment through exposure to the major areas of human knowledge, to develop a thorough understanding of the scientific method upon which all scientific endeavor is based, and to provide the special and technical knowledge which accrues from a penetrating study of a particular discipline in the pure and applied sciences.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Pure and Applied Science is organized into six departments and is administered by a dean and assistant dean who are assisted by an all-college council. The six departments are responsible for developing course offerings and programs of studies. Although the faculty of the college has overall responsibility for all academic policies of the college, the undergraduate academic standards and curriculum committee is responsible for enforcing the academic standards of the pure and applied sciences faculty and also serves as a review body for suspended students seeking readmission with probationary status.

Undergraduate Academic Standards and Curriculum Committee

Dr. Frank P. Colby, Jr., Earth Sciences
Dr. Judith Kelley, Chemistry
Dr. Arthur Mittler, Physics and Applied Physics, Chairperson
Prof. Paul Protopapas, Biological Sciences
Prof. William Maloney, Computer Science
Dr. Joyce W. Williams, Mathematics

College Council

Dr. Arthur Watterson, Acting Dean
Prof. F. Raymond Hardy, Assistant Dean
Prof. William Moloney, Computer Science
Dr. Charles Byrne, Mathematics
Dr. Aram S. Karakashian, Physics and Applied Physics
Dr. Arnold L. O'Brien, Earth Sciences
Dr. Thaddeus V. Osmolski, Biological Sciences
Dr. Samuel Sawan, Chemistry

BACCALAUREATE DEGREE PROGRAMS

The College of Pure and Applied Science offers undergraduate programs leading to the Bachelor of Arts degree and to the Bachelor of Science degree. Students who matriculate for the degree of Bachelor of Arts may pursue majors in chemistry or environmental sciences. Students who matriculate for the degree of Bachelor of Science may pursue majors in biological sciences, chemistry, computer science, environmental sciences (geology option), mathematics, meteorology, physics, and radiological health physics. Students should consult the Graduate School bulletin for information concerning master's programs in biological sciences, chemistry, computer science, mathematics, physics and applied physics, polymer science, radiological sciences and protection, and doctoral programs in chemistry, computer science and, physics and applied physics.

In addition to satisfying general University requirements for baccalaureate degrees as are defined elsewhere in this publication under the heading "Academic Policies: Baccalaureate Degrees," students who matriculate for degrees in the College of Pure and Applied Sciences also must complete a specific minimum number of courses and credits in the College of Pure and Applied Sciences. These college requirements are described below. Except as specified by the college and program restrictions, students are permitted to elect any course for which they can satisfy prerequisite requirements in fulfilling an unrestricted elective requirement. However, in order to designate courses from other colleges of the University as science or mathematics courses, students must petition the chairperson of the department in which they are enrolled as majors.

Some degree candidates in the College of Pure and Applied Sciences may be interested in pursuing a second major which is offered by the college or another college of the University. Students who wish to elect a second major should consult the relevant policies which appear elsewhere in this publication under the heading "Academic Policies: Major Field Requirements." Students who elect academic majors in more than one college are candidates for one degree only, and they are considered to be degree candidates in the college of their initial major unless they indicate to the contrary at the time they make a declaration of second major by filing for intercollegiate transfer. Accordingly, a student who pursues academic majors in two colleges is subject to all degree requirements as specified by the college of his or her initial major and is subject only to major course requirements (including any collateral and prerequisite courses for the major) as specified by the department of his or her second major.

Minor areas of study which are offered by the College of Pure and Applied Sciences are as follows: biological sciences, chemistry, geology, mathematics, physics, and radiological health physics. College majors may wish to consider these minors, other minors which are offered by the College of Liberal Arts, the College of Management Science, the College of Music, and specialized course sequences of the College of Engineering. All minor programs of the University require 18-24 credits, six of which must be at the 300 course level or above.

Bachelor of Arts Degree

Curricula leading to the Bachelor of Arts degree are designed to provide a broad, comprehensive education and generally provide more liberal options than are permitted within Bachelor of Science programs. All Bachelor of Arts programs which are offered by the College of Pure and Applied Sciences require, as a minimum, 60 credits in science and mathematics courses; at least three courses are required in mathematics and four courses are required in science which are not in the student's field. Bachelor of Arts programs of the College also require, as a minimum, 45 credits and 15 courses from the offerings of the College of Liberal Arts, the College of Music, and the economics offerings of the College of Management Science. For Univeristy policies concerning majors presented for the Bachelor of Arts degree, see policies which appear elsewhere in this publication under the heading "Academic Policies: Major Field Requirements."

Bachelor of Science Degree

The Bachelor of Science degree is designed to provide students with a specialized education in one or more of the basic sciences. Specialized Bachelor of Science curricula which are offered in areas of the pure and applied sciences and mathematics provide opportunities for major and minor program options but afford greater opportunities for major specialization than are permitted in comparable Bachelor of Arts curricula.

All Bachelor of Science programs require, as a minimum, 74 credits and 20 courses from the offerings of the College of Pure and Applied Sciences. At least three courses are required in mathematics beyond pre-calculus mathematics and must include two calculus courses and one additional mathematics elective.

Four science lecture courses with corequisite laboratories are required. The departmental distribution must conform to one of the following four alternatives:

1. Two from each of two departments in the College of Pure and Applied Science.
2. Four from one department in the College of Pure and Applied Science.
3. Three from Physics and one from any department in the College of Engineering.
4. Two from Physics and two from any one department in the College of Engineering.

For Univerity policies concerning majors presented for the Bachelor of Science degree, see policies which appear elsewhere in this publication under the heading "Academic Policies: Major Field Requirements."

GENERAL COLLEGE REQUIREMENTS

In order to qualify for a baccalaureate degree offered by the College of Pure and Applied Sciences, undergraduates must comply with the University core requirements, must conform to the rules of the College of Pure and Applied Sciences which govern degree and major studies for such degrees, and must earn 2.00 averages in their major fields by the end of their senior year.

Language Proficiency Requirement

Although the College of Pure and Applied Sciences does not require langauge proficiency, each department has the prerogative of specifying a level of language proficiency as a collateral requirement for major studies. Students matriculating for the Bachelor of Science degree who major in chemistry must pass either two semesters of a foreign language at the elementary level, or one semester at the intermediate level or above. Students majoring in science areas or mathematics who anticipate further studies at the graduate level are strongly advised to develop an intermediate reading proficiency in French or German.

Declaration of Major and Change of Major

Students who are admitted to the College of Pure and Applied Sciences are advised to declare their major fields during their freshman year and are required to make such declaration at the end of the sophomore year. Students should consult policies listed elsewhere in this publication under the heading "Academic Policies: Major Field Requirements" for a complete discussion of declaration of major, declaration of second major, change of major within the college of enrollment, and changes of major with intercollegiate transfer.

Transfer Policies

Students transferring to the College of Pure and Applied Sciences from other colleges of the University or from other institutions may expect recognition of previously completed courses if these are equivalent to those which are specified by curricula of the College. Prerequisites for courses of the major field requirements, or courses which are prerequisites for admission to the College, may not be credited to the minimum requirements for a baccalaureate degree in mathematics or the sciences. Irrespective of any previous recognition by the office of admissions or by other colleges of the University, a student who transfers from another college of the University to the College of Pure and Applied Sciences may not have either group of the above prerequisite courses credited to minimum degree requirements of the college.

Transfer From Other Institutions

Courses which are transferred from other institutions are initially evaluated by the office of admissions in terms of general University requirements when a student is admitted to the University and also are evaluated by major departments in terms of college and program requirements at the time a student is accepted for matriculation by the College of Pure and Applied Sciences. Courses which are transferred to the University under provisions of the Commonwealth Transfer Compact and which are not creditable to requirements of the College of Pure and Applied Sciences or as unrestricted elective courses will be listed on the student's transcript but will not apply to the minimum degree requirements. In the event that a student who has transferred to the University under the Commonwealth Transfer Compact subsequently makes an intercollegiate transfer to the College of Pure and Applied Sciences all previously completed courses, including transferred courses from other institutions, will be reevaluated in terms of their applicability to degree requirements of the College of Pure and Applied Sciences.

The applicability of grades received in transferred courses for the determination of the grade-point average of the student's major at the University of Lowell is determined by policies of each of the colleges. The policy of the College of Pure and Applied Sciences is not to count such grades for the purpose of determining the student's major grade-point average.

Repetition of Transferred Courses

A student who has been granted transfer credit, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred when the competence of the student has been demonstrably inadequate. Permission to repeat a transferred course is granted by filing an academic petition form through the office of the college dean. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

Intercollegiate Transfer to the College of Pure and Applied Sciences

Students wishing to transfer from another college of the University, or from baccalaureate continuing-education programs of the Evening School, must file a petition, together with a transcript, with the appropriate chairperson and the Dean of the College of Pure and Applied Sciences by November 1 for spring semester transfer and by April 1 for fall semester transfer. Students are referred to University policies concerning intercollegiate transfer which appear elsewhere in this publication under the heading "Academic Policies: Change of Major with Intercollegiate Transfer" for further procedural details. Records of students who are approved for transfer are reviewed by the office of the dean and, irrespective of grades previously received in other college programs, all courses which may not be applied to college or program requirements are deleted from the student's cumulative grade-point average.

Masters Program in Education

For those students interested in teaching, the College of Education offers a graduate degree program designed to prepare elementary teachers and secondary teachers in Biology, Chemistry, Earth Science, Mathematics, and Physics.

This year-long program (September to June) provides the course work and the apprentice teaching experience required for certification in Massachusetts and in thirty-three other states.

See graduate catalogue for requirements for admission.

Interested persons may obtain additional information from Dr. Gail M. Carney, Director of Field Experiences, College of Education.

DEPARTMENT OF BIOLOGICAL SCIENCES

Thaddeus Osmolski, Chairperson

Professors: John Bruce, Robert Coleman, Jerome Hojnacki, Ethel Kamien, Thaddeus Osmolski, Nicholas Rencricca, Ezequiel Rivera, Robert Lynch, John Mallett

Associate Professors: David Eberiel, Curtis Hinckley, John Lyon, Paul Protopapas, Ilze Skare, Lee Jun Wong

Assistant Professors: Siu-Lam Lee, Prentiss Shepherd

Biological Science Major

The Department of Biological Sciences offers a major program which leads to the degree of Bachelor of Science with two program options: Biology and Biotechnology. The department also offers a minor area of study.

Curricula in the biological sciences are designed to provide appropriate sequences of science and liberal arts courses which will develop those scientific attitudes, habits of mind, and areas of knowledge which are fundamental to successful careers in biology and cognate fields.

Students who select the biology option are provided with the opportunities to tailor their undergraduate education in accordance with their personal interests and career goals or with the requirements of graduate or professional schools. Undergraduates may opt to explore the many fields of biology, to combine biological training with training in other departments (e.g. chemistry, radiation health physics, psychology), or to concentrate in a single discipline such as molecular biology, microbiology, immunobiology, nutritional science, environmental science, cell biology, etc.). Students demonstrating a high scholastic ability are encouraged to conduct an original research project in their senior year. Successful undergraduate investigative studies have included projects in many areas ranging from molecular biology through biomedical research and into population studies. Valuable technical training gained from such experiences include electron microscopy, recombinant DNA technology, computer applications, and the whole spectrum of biochemical techniques.

Students who select the biotechnology option will obtain a background and training appropriate to developing careers in genetic engineering, industrial microbiology, cell culture/hybridoma technology, and the fermentation industry. Students are able to integrate training in other departments such as chemical engineering and chemistry to enhance their preparation to embark on a career in this exciting field.

The curricula for the two options are virtually identical for the first four semesters so students need not commit themselves before the beginning of the junior year. Even after this point, transfer from one option to the other is facilitated by the high degree of commonality between the two programs. In either case, students have an excellent preparation to enter careers directly after attaining the Bachelor of Science degree or to exploit the credentials afforded by this degree as the basis for graduate study.

Pre-Health Professional Training

The curricula in the Department of Biological Sciences satisfy entrance requirements for schools of medicine, dentistry, veterinary medicine, osteopathic medicine, and optometry. Students who anticipate application to professional schools should register with the pre-health professional advisor who, along with a college-wide committee, will guide students in attaining their professional goals and will act as an informational resource for questions concerning the admission process.

Five-Year B.S./M.S. Program in Biological Sciences

In recognition of the need for advanced training beyond the bachelor of science level in biological sciences, the following represents a program by which outstanding undergraduates can pursue an accelerated five-year course of study leading to the B.S. and M.S. degrees in Biological Sciences.

Undergraduate students who express an interest in this program will be evaluated by the department graduate selection committee. Those students deemed commendable by the committee will be advised on the correct procedure for successful completion of their B.S. degree, as well as a course of study toward the M.S. degree.

The first two years of undergraduate study will be identical to that which is specified for students enrolled in the current four-year B.S. program. The junior year of study will be essentially the same as that of the four-year B.S. program, except that the student will be expected to take on an additional undergraduate elective course each semester. This will not constitute an overload, since 18 credits per semester will not be exceeded. This will allow greater flexibility to pursue graduate-level training during the senior year. During the second semester of the junior year and upon approval and recommendation by the department graduate selection committee, the student will file formal application to the Graduate School. Application does not require the student to have taken the GRE examination. The committee decision will be based on: (a) overall grade point average, (b) grade point average in selected subjects, (c) recommendations by department faculty, and (d) a 1-year minimum residency requirement at the University of Lowell. Upon approval and recommendation by the Dean of the Graduate School, the student may be allowed to pursue graduate studies during the senior year and officially become a provisional graduate student in the second semester of the senior year.

During the senior year, the student will be permitted to take up to two graduate-level courses each semester, which can be applied towards the M.S. degree. Although advanced undergraduate (i.e. 400 level) courses are acceptable, no more than two such courses will be allowed towards the M.S. degree. It should be emphasized that the total number of credits earned towards the combined degrees must be greater than the minimum number of credits required for the undergraduate B.S. degree. The University Bachelor of Science minimum requirement is 120 credits. The student may, with approval, transfer any additional graduate-level credits toward the M.S. degree, excluding those employed for the B.S. degree.

Upon successful completion of the fourth year of study, by which time all department and university requirements should have been met, the student will be awarded the B.S. degree. The student is then advised to take the Graduate Record Examinations required by the Graduate School. The department graduate selection committee and the Dean of the Graduate School may then recommend the student for full matriculation status prior to the fifth year of study. Should the student choose not to continue toward the M.S. degree, there would be no impact on the bachelor's degree earned.

Although options exist for taking an overload in any semester and/or registration for one or more summer sessions, they are not a requirement of this program. However, students wishing to gain a full research experience will be encouraged to initiate their research as early as possible (e.g. summer session between junior and senior year), which is a distinct advantage of this accelerated program.

During the fifth year, as in the standard M.S. degree program, the student may undertake: (a) thesis option (6-12 semester hours of Graduate Research), (b) project option (1-6) semester hours of Graduate Project), or (c) non-research option. In either case, the student will be required to take two 2-credit Graduate Seminar courses (81-601; 81-602) and must satisfy the 30 credit minimum M.S. degree requirement. If the student has gained full matriculation status, he/she would be eligible for a teaching assistantship during the fifth year. Upon completion of all departmental and Graduate School requirements, the student will be awarded the M.S. degree.

Summary Of Degree Requirements (Biological Sciences)

1. University Core Requirements

Students must conform to the guidelines for University core requirements outlined in the appropriate section of this document, including the distribution of electives among different departments in both social/behavioral sciences (Area I), humanities (Area II) and present at least one course to satisfy the human values requirement.

Physical Activities Requirement	2
English Composition Requirement	6
Area I & II Distribution Requirements	18

2. Major Field Requirements for All Programs

A. Biological Sciences	**27**
81-111 Principles of Biology I	3
81-113 Principles of Biology I Laboratory	1
81-112 Principles of Biology II	3
81-114 Principles of Biology II Laboratory	1
81-201 General Microbiology	3
81-203 General Microbiology Laboratory	3
81-252 Physiology	3
81-254 Physiology Laboratory	1
81-335 Principles of Genetics	3
81-337 Principles of Genetics Laboratory	1
81-419 Biochemistry	3
81-421 Techniques in Biochemistry	2
81-451 Senior Seminar in Advanced Topics I	1
81-452 Senior Seminar in Advanced Topics II	1

B. Supporting Sciences and Mathematics 38

84-121	Chemistry	3
84-123	Chemistry Laboratory	1
84-122	Chemistry	3
84-124	Chemistry Laboratory	1
84-221	Organic Chemistry IA	3
84-229	Organic Chemistry Laboratory IA	1
84-222	Organic Chemistry IIA	3
84-230	Organic Chemisty Laboratory IIA	1
92-131	Calculus I	4
92-132	Calculus II	4
92-263	Fortran Programming	3
92-385	Biostatistics	3
95-201	Principles of Physics I and	3
95-202	Principles of Physics II and	3
96-103	General Experimental Physics I and	1
96-104	General Experimental Physics II	1

3. Additional Requirements

A. Biology Option 31

Four 3-5 credit electives with an “81” prefix at a 300 level or above, two of which must have a laboratory component	14
Free electives exclusive of courses with an “83” prefix and mathematics courses below the level of Calculus I	17

B. Biotechnology Option 31

81-200	Introduction to Biotechnology	1
81-467	Recombinant DNA	2
81-469	Recombinant DNA Laboratory	1
81-476	Cell Culture & Hybridoma Techniques	2
81-478	Cell Culture & Hybridoma Laboratory	1
81-493	Immunobiology	3
81-495	Immunobiology Laboratory	1
81-482	Selected Topics in Biotechnology	2
84-324	Principles of Analytical Chemistry	3
84-325	Principles of Analytical Chemistry Laboratory	1

Two approved professional electives	6
Free electives, exclusive of courses with an “83” prefix and mathematics courses below the level of Calculus I	8

4. Minimum Credit Requirements 122

Prerequisites for courses in the major field, or courses which are prerequisites for admission to the College of Pure and Applied Sciences, may not be credited to requirements for degrees in the College of Pure and Applied Sciences. All Bachelor of Science programs require, as a minimum, 74 credits and 20 courses from the offerings of the College of Pure and Applied Sciences.

SAMPLE COURSE OF STUDY FOR BIOLOGICAL SCIENCES (Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
81-111	Principles of Biology I	3	81-112	Principles of Biology II	3
81-113	Principles of Biology I Lab	1	81-114	Principles of Biology II Lab	1
84-121	Chemistry I	3	84-122	Chemistry II	3
84-123	Chemistry I Laboratory	1	84-124	Chemistry II Laboratory	1
92-131	Calculus I	4	92-132	Calculus II	4
42-101	College Writing	3	43-102	College Writing & Lit.	3
39-	Physical Education	1	39-	Physical Education	1
		16			16

Sophomore Year

Fall Semester			Spring Semester		
81-201	General Microbiology	3	81-252	Physiology	3
84-203	General Microbiology Lab	1	81-254	Physiology Laboratory	1
84-221	Organic Chemistry I-A	3	84-222	Organic Chemistry II-A	3
84-229	Organic Chemistry I-A Lab	1	84-230	Organic Chemistry II-A Lab	1
92-263	Fortran Programming	3	92-385	Biostatistics	3
	Electives	3-4		Electives	3-4
		14-15			14-15

Junior Year

Fall Semester			Spring Semester		
81-419	Biochemistry	3	81-421	Techniques in Biochemistry	2
81-335	Principles of Genetics	3	95-202	Principles of Physics II	3
81-337	Principles of Genetics Lab	1	96-104	Gen. Experimental Physics II	1
	Electives	4		Electives	9
95-201	Principles of Physics I	3			
96-103	Gen. Experimental Physics I	1			
		15			15

Senior Year

Fall Semester			Spring Semester		
81-451	Sen. Sem. in Advanced Topics	1	81-452	Sen. Sem. in Advanced Topics	1
	Electives	15		Electives	14
		16			15

SAMPLE COURSE OF STUDY FOR BIOLOGICAL SCIENCE: BIOTECHNOLOGY OPTION (Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
81-111	Principles of Biology I	3	81-112	Principles of Biology II	3
81-113	Principles of Biology I Lab	1	81-114	Principles of Biology II Lab	1
84-121	Chemistry I	3	84-122	Chemistry II	3
84-123	Chemistry I Laboratory	1	84-124	Chemistry II Laboratory	1
92-131	Calculus I	4	92-132	Calculus II	4
42-101	College Writing	3	42-102	College Writing & Lit.	3
39-	Physical Education	1	39-	Physical Education	1
		16			16

Sophomore Year

Fall Semester

81-201	General Microbiology	3
81-203	General Microbiology Lab	1
84-221	Organic Chemistry I-A	3
84-229	Organic Chemistry I-A Lab	1
92-263	Fortran Programming	3
95-201	Principles of Physics I	3
96-103	Gen. Experimental Physics I	1
		15

Spring Semester

81-200	Intro. to Biotechnology	1
81-252	Physiology	3
81-254	Physiology Laboratory	1
84-222	Organic Chemistry II-A	3
84-230	Organic Chemistry II-A Lab	1
	University Core Requirements	3
95-202	Principles of Physics II	3
96-104	Gen. Experimental Physics II	1
		16

Junior Year

Fall Semester

81-419	Biochemistry	3
81-335	Principles of Genetics	3
81-337	Principles of Genetics Lab	1
	Electives	9
		16

Spring Semester

84-324	Prin. of Analytical Chem.	3
84-325	Prin. of Analyt. Chem. Lab	1
91-421	Techniques in Biochemistry	2
	Electives	6
92-385	Biostatistics	3
		15

Senior Year

Fall Semester

81-451	Sen. Sem. in Advanced Topics	1
81-493	Immumobiology	3
81-495	Immunobiology Laboratory	1
81-467	Recombinant DNA	2
81-469	Recombinant DNA Laboratory	1
	Elective in Biotechnology*	3-4
	Elective	3
		14-15

Spring Semester

81-452	Sen. Sem. in Advanced Topics	1
81-482	Sel. Topics in Biotech.	2
	Electives in Biotech.*	6-8
81-476	Cell Culture & Hybridoma	2
81-478	Cell Culture & Hybidoma Lab	1
		12-14

* Designated electives in other departments which are pertinent to Biotechnology may be used here.

Biological Sciences Minor

A minor in biological sciences consists of the following:

1. A year sequence of a course in introductory biology with a laboratory component. This requirement may be satisfied by electing the lecture and laboratory sections in either the Principles of Biology or Life Science courses.
2. Four additional 3 or 4 credit courses with an "81" prefix offered by the Department of Biological Sciences. Two of these courses must have a laboratory component. At least 6 credits must be at the 300 level or above.

Pure and Applied Biology (Course Prefix: 81)

Courses designed primarily to satisfy the requirements of students majoring or minoring in biological sciences: they may also serve as electives for others with specialized interests.

81-111 PRINCIPLES OF BIOLOGY I **I,(3,0)3**
Introduction to biological systems above the unit organismal level. Study of plants and animals with respect to reproduction and development, behavior, genetics, evolution, ecology, and biogeography. Corequisite: 81-113.

81-112 PRINCIPLES OF BIOLOGY II **II(3,0)3**
An introduction to the structure and function of biological processes at the sub-cellular, cellular, and organismal levels. Discussions include metabolism, growth, differentiation, and physiology of plants and animals. Corequisite: 81-114.

81-113 PRINCIPLES OF BIOLOGY I LABORATORY **I(1,3)1**
A series of field trips and laboratory exercises designed to introduce the student to concepts of the distribution and maintenance of life. Specific consideration is given to the diversity and organization of local ecosystems; the continuation of life is considered through exercises covering mitosis, meiosis, genetics and evolutionary biology. A weekly one-hour pre-laboratory recitation is an integral component of the course.

81-114 PRINCIPLES OF BIOLOGY II LABORATORY **II(1,3)1**
A series of laboratory experiments, analyses and dissections designed to introduce the student to biological techniques and processes at the sub-cellular cellular and organ systems levels. A weekly one-hour pre-laboratory recitation is an integral component of the course. Staff.

81-200 INTRODUCTION TO BIOTECHNOLOGY **II(1,0)1**
A survey of those areas in applied biology of economic importance and of special interest to the industrial community.

81-201 GENERAL MICROBIOLOGY **I(3,0)3**
A study of the general properties of bacteria and viruses (anatomy, physiology, genetics, metabolism, cultivation, and growth), discussions include major microbial infections man (etiologic agent, antibiotics and chemotherapy) and an examination of the role of the microbes in the environment. Prerequisites: 84-122, 81-111, 81-112. Corequisite: 81-203.

81-203 GENERAL MICROBIOLOGY LABORATORY **I(0,3)1**
A series of laboratory exercises covering basic qualitative and quantitative techniques in microbiology.

81-215 INTRODUCTION TO MARINE BIOLOGY **II(2,0)2**
An introduction to the marine environment with major consideration given to the biological and ecological aspects. Emphasis is on the flora and fauna of New England. Several field trips are required. Corequisite: 81-217.

81-217 INTRODUCTION TO MARINE BIOLOGY LABORATORY **II(0,3)1**
A series of laboratory exercises and field trips designed to emphasize the material covered in 81-215.

81-224 INTRODUCTION TO INSECT BIOLOGY **II(2,0)2**
A survey of the major groups of insects. Topics include their structures, importance, and relationship to man. Prerequisites: 81-111, 81-112 or 83-101, 83-102. Corequisite: 81-226.

81-226 INTRODUCTION TO INSECT BIOLOGY LABORATORY **II(0,2)1**
A series of laboratory studies dealing with the structures, diversity and collection techniques of insects. Corequisite: 81-224.

81-228 ORNITHOLOGY **II(2,0)2**
This course covers the various aspects of the biology of birds, including their structure, physiology, classification, field and laboratory identification, adaptations, behavior, distribution, ecology, life histories, evolution, and relationship to man, with special emphasis on the avifauna of New England. Prerequisites: 81-111, 81-112 or 83-101, 83-102. Corequisite: 81-230.

81-230 ORNITHOLOGY LABORATORY **II(0,3)1**
A series of laboratory exercises designed to emphasize the material covered in 81-228.

81-252 PHYSIOLOGY **II(3,0)3**
A comprehensive study into the fundamental mechanisms governing mammalian physiology. The integration of cell physiology into biological control systems and coordinated body functions, with regard to the maintenance of homeostasis, will be considered in terms of biochemical, cytological, anatomical and physical principles. In each instance the experimental approach into the derivation of physiological principles will be presented and areas of further investigation will be emphasized. In all cases, the research aspects will be shown. Prerequisite: 81-111, 81-112. Corequisite: 84-222, 81-254.

81-254 PHYSIOLOGY LABORATORY **II(0,3)1**
A series of laboratory exercises and experiments to demonstrate physiological principles with an emphasis on human function.

81-302 DEVELOPMENTAL BIOLOGY **II(3,0)3**
Developmental phenomena are studied at the levels of macromolecules, subcellular organelles, cells, and interaction among cells. The emphasis is on current research in cellular differentiation, morphogenetic movements, nucleocytoplasmic interaction and organismal integration by nervous and hormonal mechanisms. Readings in the research literature are an integral part of the course. Prerequisites: 81-lll, 81-112.

81-306 INVERTEBRATE ZOOLOGY **I(3,0)3**
A survey of the phyla of invertebrate animals. Discussions include their physiology, development, morphology, behavior, ecology and adaptations. Corequisite: 81-308.

81-308 INVERTEBRATE ZOOLOGY LABORATORY **I(0,3)1**
A broad spectrum of living and preserved specimens are studied in the laboratory with regard to both structure and function.

81-315 PRINCIPLES OF ECOLOGY **I(2,0)2**
A series of lectures concerned with interrelationships of organisms with their abiotic environment with emphasis on the New England area. Selected current topics will supplement the text. Prerequisites: 8l-111, 81-112, and 113 and 114. Corequisites: 81-317.

81-317 PRINCIPLES OF ECOLOGY LABORATORY **I(0,4)2**
A series of laboratory exercises to supplement and illustrate lectures of 81-315. Field trips are an integral part of the course involving analysis and sampling of such components as water, soil, invertebrate fauna and characteristic flora. Directed reading, laboratory quizzes, practical exam and oral presentation of a research topic are also integral parts of the course. Corequisite: 81-315.

81-320 BOTANY **II(3,0)3**
An introduction to the plant kingdom dealing with the structure, function and diversity of plants with an emphasis on seed plants. The cytology, ecology, morphology, physiology and taxonomy of plants is considered. Corequisite: 81-322.

81-322 BOTANY LABORATORY **II(0,3)1**
Greenhouse and laboratory exercises designed to emphasize material covered in 81-320.

81-327 HISTOLOGY **II(3,0)3**
An introduction to the microscopic structure of animal tissues with emphasis upon human histology. Laboratory investigation is an integral part of the course. Prerequisites: 81-111, 81-112, 81-113, 81-114. Corequisite: 81-329.

81-329 HISTOLOGY LABORATORY **II(0,3)1**
A series of laboratory exercises designed to emphasize the material covered in 81-327. Corequisite: 81-327.

81-335 PRINCIPLES OF GENETICS **I(3,0)3**
The theories of both classical and molecular genetics are explored with emphasis on the experimental evidence which has laid the foundation for contemporary understanding of genetics. Included is the nature of the genetic material, gene action, genetic recombination, gene regulation, gene interaction, the production and inheritance of phenotypes, chromosomal mechanics, and the behavior of genes in populations. Prerequisite: 81-111, 81-112, 84-222. Corequisite: 81-337.

81-337 PRINCIPLES OF GENETICS LABORATORY **I(0,3)1**
Laboratory investigations of the transmission and expression of morphological and physiological characters in both eukaryotic and prokaryotic organisms.

81-342 COMPARATIVE VERTEBRATE ANATOMY **II(3,0)3**
A study of the basic similarities and differences of organ systems in the vertebrates, with reference to the fields of embryology, histology, and paleontology. Representative vertebrates are studied in the laboratory. Prerequisites: 8l-111, 81-112, 81-113, 81-114. Corequisite: 81-334.

81-344 COMPARATIVE VERTEBRATE ANATOMY LABORATORY **II(0,4)2**
A series of exercises designed to emphasize the material covered in 81-342. Corequisite: 81-342.

81-347 HUMAN NUTRITION **I(3,0)3**
This course emphasizes fundamental physiological and biochemical principles of human nutrition. A basic course in physiology is a prerequisite. Students will have an opportunity to compare their present dietary practices with recommended dietary allowances, and dietary goals and guidelines. Nutrient excesses and inadequacies during various stages of the life cycle (pregnancy, infancy, childhood, adolescence, adulthood, old age) will be considered. Current concepts and controversies in nutrition research, surveys and methods will also be evaluated.

81-401,402 BIOLOGY PRACTICUM I, II **I(0,3)1; II(0,3)1**
Through observation, preparation of material and presentation of demonstrations in selected courses offered by the Department of Biological Sciences, the student becomes familiar with the materials and teaching-learning situations in biology.

81-411,412 SENIOR RESEARCH IN BIOLOGY **I(0,12)4; II(0,12)4**
An individual, directed one-year research program for senior biology majors selected on the basis of previous academic performance at the end of the junior year. A topic will be chosen after consultation with a faculty member. A report of the research in the form of a thesis is required. Students may not receive credit for either 411 or 412 alone.

81-419 BIOCHEMISTRY **I(0,3)3**
A study of the structure and properties of proteins, carbohydrates, and lipids which combine with a discussion of elementary enzymology allows for detailed descriptions of several important degradative and biosynthetic pathways, their integration and regulation. Throughout the course, emphasis is on methods and practical application of fundamental information to the solution of problems of current biomedical interest. Prerequisites: 84-222 and 84-344 recommended.

81-420 BIOCHEMISTRY II **II(3,0)3**
A continuation of 81-419 which will include the following topics: (a) biosynthesis and degradation of amino acids, purine and pyrimidine nucleotides, and regulation of these metabolic pathways, (b) structure and function of chromatin, DNA and RNA, (c) mechanism of DNA, RNA and protein biosynthesis and regulation of gene expression.

81-421 TECHNIQUES OF BIOCHEMISTRY **II(1,5)2**
A series of discussions and "hands on" laboratory exercises emphasizing techniques and use of equipment most commonly employed in biochemical-biomedical research laboratories. Techniques to be mastered include: cell culture, cell fractionation, enzyme purification, ultracentrifugation, UV-visible spectrophotometry, various types of chromatography (thin layer, gas, gel exclusion, ion exchange), electrophoresis, liquid scintillation spectrometry, and the safe handling and application of radioisotopes to problems in biochemistry. Wherever possible, the principles presented in 81-419 will be used as a basis for experimentation using the above techniques. Prerequisite: 81-419 or the equivalent.

81-422 PLANT PHYSIOLOGY **II(3,0)3**
A critical study of the physiological processes which occur in plants, with emphasis on the angiosperms. Topics include growth and development, water relations, mineral nutrition, photosynthesis, and nitrogen metabolism. Prerequisites: A year of college biology and college chemistry. Some organic chemistry would be helpful. Co-registration for the laboratory (81-424) is recommended but not required.

81-424 PLANT PHYSIOLOGY LABORATORY **II(0,4)1**
A series of laboratory and greenhouse experiments and analyses to illustrate the material in 81-422.

81-431 QUANTITATIVE ECOLOGY **I(3,0)3**
A quantitative presentation of the dynamic processes which influence the distribution and abundance of organisms in the biosphere. Consideration is directed toward field and laboratory investigations of current problems with emphasis on design and analysis of experiments. Energy flow, nutrient cycling, population growth and regulation, species diversity, community homeostasis and systems modeling techniques are examined and computer applications are discussed. Prerequisite: 92-385, 81-111, 81-112. Corequisite: 81-433.

81-433 QUANTITATIVE ECOLOGY LABORATORY **I(0,3)1**
A series of field and laboratory analyses to determine quantitative relationships between organism and environment.

81-442 CELL BIOLOGY **I(3,0)3**
Deals with the study of the cell and its cytoplasm incorporating the structure of cell membranes and the organelles they define; specialized organelles dealing with energy capture and transduction, some aspects of histochemical and biochemical studies on cytoplasmic organelles at the electron microscopic level. An introduction into cytogenetics and nuclear cytology; a brief discussion of prokaryotic cells. Prerequisite: 81-419 and permission of instructor. Corequisite: 81-444.

81-444 CELL BIOLOGY LABORATORY **I(0,3)1**
Introduction to the optical microscope as an analytical tool. Individual laboratories using a variety of instruments designed to acquaint the student with the analysis of cells. Analysis of biological ultrastructure at the optical and electron microscopic level. Corequisite: 81-442.

81-451,452 SENIOR SEMINAR IN ADVANCED TOPICS **I(1,0)1; II(1,0)1**
Seminar discussion of selected topics of current research interest. An oral seminar presentation as well as a written report are required of all biology seniors.

81-467 RECOMBINANT DNA **I(2,0)2**
A study of the principles and specialized techniques of purifying, manipulating and cloning of recombinant DNA molecules. Includes restriction enzyme mapping, cloning of DNA from prokaryotes and eukaryotes, types of plasmid and viral vectors used in genetic engineering, and the applicability of these techniques to solution of various problems in cell biology. Prerequisites: 81-419, 81-335 or 81-472.

81-469 RECOMBINANT DNA LABORATORY **I(0,4)1**
A series of laboratory exercises designed to illustrate the material presented in 81-467.

81-472 VIROLOGY **II(3,0)3**
A study of bacterial and animal viruses including viral structure, modes of replication, biochemistry of the infected cell, genetic properties, and viral oncogenesis. Emphasis is on virus-cell interactions at the molecular level. Prerequisites: 81-201 or 81-335.

81-474 VIROLOGY LABORATORY **II(0,3)1**
A series of laboratory exercises covering current techniques in bacterial and animal virology. Included are virus propagation and titration, cell culture, and biochemical, biophysical, and genetic analyses of viral nucleic acids and proteins.

81-476 CELL CULTURE AND HYBRIDOMA **II(2,0)2**
A series of lectures focused on the biology and culture of cells in vitro, followed by specialized methodologies with applications to hybridoma technology.

81-478 CELL CULTURE AND HYBRIDOMA LABORATORY **II(0,4)1**
Laboratory exercises will emphasize aseptic techniques, media preparation, and the establishment and maintenance of cultured cells. Specialized hybridoma techniques will include: immunization, cell fusion, cloning, identification of antibody producing hybridomas as well as the production and purification of monoclonal antibodies.

81-482 SELECTED TOPICS IN BIOTECHNOLOGY **II(3,0)3**
One or more topics of current interest will be explored in depth by means of lecture presentations, seminar discussions, and extensive library research. The content will vary from year to year and will be tailored to suit the needs of seniors in the biotechnology option. Enrollment limited to senior biotechnology majors and others with permission of the department chairperson.

81-485 EUKARYOTIC GENE EXPRESSION **I(3,0)3**
A study of the regulation of gene expression in eukaryotic cells. Emphasis will be given to the methodologies of studying the regulation of gene expression at transcriptional and post transcriptional levels during hormonal activation, cell development and cell transformation. The structure and organization of eukaryotic genes will also be discussed. Prerequisite: 81-419, 81-335 or equivalent.

81-491,492 SENIOR PROJECT IN BIOLOGY **I(0,12)4; II(0,12)4**
An individual, directed one semester research project taken in the fall and/or spring. Presentation of an acceptable project plan at the time of registration is required. A project report is required.

81-493 IMMUNOBIOLOGY **I(3,0)3**
A study dealing with the biology of the immune response with sections on antibody production, reaction with antigen, suppression, tolerance, protection and injury. Prerequisite: 81-201, 81-419. Corequisite: 81-495.

81-495 IMMUNOBIOLOGY LABORATORY **I(0,3)1**
A series of laboratory exercises dealing with the preparation, isolation, characterization, and reaction of antigens, antibodies and effector cells.

81-496 PRACTICUM EXPERIENCE **I,II(0,9)3**
A program of campus and/or off-campus experiences which are developed by the student in consultation with a member of the student's major department. Specific requirements will vary, depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a scientific area and for applying techniques of problem solving and/or skills which are appropriate to the student's major discipline. The practicum experience may not be substituted for a required course in the major. Prerequisite: permission of department chairperson.

81-497,498 SELECTED TOPICS IN BIOLOGY **I,II(3,0)(3,0)3**
Advanced topics in various fields of biology. Content may vary from year to year so that students may, by repeated enrollment, acquire a broad knowledge of contemporary biology. Prerequisite: permission of instructor.

81-501,502 SELECTED TOPICS IN BIOLOGY **(3,0)(3,0)6**
Current topics in various fields of biology presented in lecture, seminar or discussion groups. Subject matter may vary depending on interests of instructor and needs of students. May be repeated for credit when course content differs. Prerequisite: permission of instructor.

81-503 BIOCHEMISTRY OF METABOLIC DISORDERS **(3,0)3**
This course deals with the biochemical alterations, nutritional considerations, pathophysiology, methods of detection and treatment of the following disturbances in lipid and carbohydrate metabolisms: diabetes mellitus, obesity, alcoholism, senile dementia, gallstone formation, respiratory distress syndrome, atherosclerosis, familial hypercholesterolemia, LCAT deficiency, and Tangier, glycogen storage, Tay-Sachs and Niemann-Pick disease. Current concepts in total parenteral nutrition and biochemical methodology employed in evaluating metabolic disorders will also be reviewed.

81-506 PHYSIOLOGICAL ECOLOGY **II(3,0)3**
A consideration of physiological evolutionary and environmental aspects of interactions between organism and environment with special emphasis on homeostatic adaptations to biotic and abiotic environmental fluctuations. Concurrent registration in 81-508 is required for biology majors. Prerequisites: 81-252, 81-431 or equivalent.

81-508 PHYSIOLOGICAL ECOLOGY LABORATORY **(0,3)1**
A series of laboratory investigations designed to illustrate basic homestatic adaptations enabling organisms to maintain internal constancy in a variable environment.

81-510 LIMNOLOGY **II(3,0)3**
An introduction to freshwater as a biogeochemical environment considering the geology, chemistry and physics of inland waters as they affect the ability of the medium to sustain life. Particular attention is addressed to basin and channel morphometry, thermal, photic, hydrologic and solvent properties of the medium. Floral and faunal components of the system are considered from populational and community aspects, evolutionary development and specific adaptations to particular niches in standing and flowing waters. Prerequisites: 81-112 and either 81-431 or 81-305.

81-512 LIMNOLOGY LABORATORY **II(0,3)1**
A series of laboratory and field exercises designed to familiarize the student with chemical, physical and biological characteristics of freshwater systems. Consideration is given to basin mapping, heat and nutrient budgets, productivity and community analysis. Corequisite: 81-510.

81-518 EXPERIMENTAL HEMATOLOGY **II(3,0)3**
An introduction to the physiology of the erythropoietic system. Emphasis will be given to the proliferation and differentiation of hemopoietic stem cells with regard to the regulation and maintenance of homeostasis. Abnormalities and perturbations resulting in diseased conditions, such as anemia and polycythemia, will also be discussed. Prerequisite: 81-252 or equivalent.

81-520 EXPERIMENTAL HEMATOLOGY LABORATORY **II(0,6)2**
A series of laboratory exercises and projects designed to employ basic and advanced techniques in hematology and which emphasize the material covered in 81-518.

81-522 PLANT PHYSIOLOGY **II(3,0)3**
Topics covered are as in 81-422. A paper representing an extensive review of a current topic is required.

81-524 PLANT PHYSIOLOGY LABORATORY **II(0,4)1**
Topics as in 81.424. Additional independent investigative work is required.

81-529 BIOCHEMICAL ASPECTS OF HEART DISEASE **I(3,0)3**
This course emphasizes a comparison of normal and pathological alterations in metabolic pathways of the heart and blood vessels. Biochemical modifications in lipid/lipoproteins, connective tissue, components (elastin, collagen, proteoglycans), and prostaglandins are discussed. Specific topics include: coronary risk factors, arterial wall metabolism, endothelial injury, platelets-thrombosis, immunological insults, nutrition and atherosclerosis, hemodynamics and regression studies. Current biochemical methods employed in cardiovascular research as well as clinical detection, diagnosis and treatment of heart disease are also presented.

81-541 TOPICS IN CELL BIOLOGY **II(3,0)3**
The fundamental structure and function of the cell will be discussed in detail. Some of the topics to be discussed are: l)the anatomy and biochemistry of cellular membranes; 2)transport mechanisms; 3)systems developed by various life forms for motility; 4)properties of excitable cells; 5)energy transduction mechanisms. Wherever possible, comparisons between the biology of normal and transformed cells will be made. May be repeated for credit when course content varies. Prerequisite: 81-419 or equivalent.

81-542 CELL BIOLOGY **I(3,0)3**
The structure and function of eukaryotic cells. Study of cell membranes and organelles they define; specialized organelles for energy capture and transduction; aspects of histochemical and biochemical studies of organelles at the optical and electron microscopic level. An introduction into cytogenetics and nuclear cytology; a brief discussion of prokaryotic cells. A substantial library investigation of some aspects of cell structure and/or function is required. Prerequisite: 81-419 or equivalent. Corequisite: 81-544.

81-544 CELL BIOLOGY LABORATORY **I(0,3)1**
Introduction to the optical microscope as an analytical tool. Individual laboratories using a variety of instruments designed to acquaint the student with the analysis of cells. Analysis of biological ultrastructure at the optical and electron-microscopic level; cell fractionation; chromosome preparations. One substantial ultrastructural analysis required. Corequisite: 81-542.

81-550 (84-550) BIOCHEMISTRY I **II(3,0)3**
This course is intended primarily for students in the biochemistry Ph.D. option and will include detailed discussion of: (a) the structure and properties of proteins, carbohydrates and lipids, (b) enzymology, (c) organization and regulation of pathways for the degrada-

tion and biosynthesis of carbohydrates, lipids and amino acids. Lectures will be supplemented with assigned readings from current research periodicals. Prerequisites: A course in physical chemistry or permission of instructor.

81-551 (84-551) BIOCHEMISTRY II I(3,0)3
A continuation of 81-550 (84-500) which will include the following topics: (a) metabolism of amino acids, (b) the structure, function and biosynthesis of DNA, RNA and their precursors, (c) the mechanisms of protein biosynthesis, and (d) regulation of nucleic acid and protein synthesis. Lectures will be supplemented with assigned readings from the current literature. Prerequisite: Biochemistry I or equivalent.

81-561 ELECTRON MICROSCOPY: THEORY (3,0)3
An introduction to the theory of electron microscopes and electron optics. Preparation of biological specimens for electron microscopic viewing and photography. Analysis of data obtained with electron microscopic techniques. Applications in biology will be discussed. Prerequisite: 81-419, and permission of instructor.

81-562 ELECTRON MICROSCOPY: LABORATORY (0,9)3
Operation of scanning and transmission electron microscopes. Project required of all students. Use of ancillary optical equipment. Prerequisite: 81-561, permission of instructor.

81-564 EXPERIMENTAL HEMATOLOGY: A STUDY OF CURRENT LITERATURE(3,0)3
This course will involve group discussions of the recent scientific literature in experimental hematology. Cellular and humoral mediators of blood cell production will be assessed relative to hemopoietic stem cell proliferation, differentiation and migration, with an emphasis on erythropoiesis. Papers dealing with abnormalities and perturbations resulting in diseased states will be included for discussion. Prerequisite: 81-518 or equivalent.

81-565 ROLE OF MICRONUTRIENTS IN MAMMALIAN NUTRITION (3,0)3
The biochemical mode of action of selected vitamins and minerals as well as mechanisms involved in regulating their absorption, conservation, and metabolism will be emphasized. Where possible their significance in the context of human nutrition and disease will be discussed. Prerequisites: 81-252, 81-419 or equivalent.

81-567 RECOMBINANT DNA I(2,0)2
A study of the principles and specialized techniques of purifying, manipulating and cloning of recombinant DNA molecules. Includes restriction enzyme mapping of genomes, cloning of DNA from prokaryotes and eukaryotes, types of plasmid and viral vectors used in genetic engineering, and the applicability of these techniques to solution of various problems in cell biology. A library investigation of a current topic is required. Prerequisites: 81-419, 81-335 or 81-472.

81-569 RECOMBINANT DNA LABORATORY I(0,3)1
A series of laboratory exercises designed to illustrate the material presented in 81-553. An independent project will be required.

81-572 VIROLOGY II(3,0)1
A study of bacterial and animal viruses including viral structure, modes of replication, biochemistry of the infected cell, genetic properties, and viral oncogenesis. Emphasis is on virus-cell interactions at the molecular level. A library investigation of a current topic is required. Prerequisites: 81-201 and 81-335 or 81-419.

81-574 VIROLOGY LABORATORY II(0,3)1
A series of laboratory experiments covering current techniques in bacterial and animal virology. Included are virus propagation and titration, biochemical, biophysical, and genetic analysis of viral nucleic acids and proteins, and cell culture techniques. An independent lab project is required.

81-576 CELL CULTURE AND HYBRIDOMA **II(2,0)2**
As in 81-476, but with additional required reading and/or seminar preparation.

81-578 CELL CULTURE AND HYBRIDOMA LABORATORY **II(0,4)1**
Exercises as outlined in 81-478, but with additional independent project required.

81-585 EUKARYOTIC GENE EXPRESSION **I(3,0)3**
A study of the regulation of gene expression in eukaryotic cells. Emphasis will be given to the methodologies of studying the regulation of gene expression at transcriptional and post transcriptional levels during hormonal activation, cell development and cell transformation. The structure and organization of eukaryotic genes will also be discussed. A library investigation of a current topic is required. Prerequisites: 81-419, 81-335 or equivalent.

81-593 IMMUNOBIOLOGY **I(3,0)3**
A study dealing with the biology of the immune response with sections on antibody production, reaction with antigen, suppression, tolerance, protection and injury. Original research proposal required. Prerequisite: 81-201, 81-419. Corequisite: 81-595 and permission of instructor.

81-595 IMMUNOBIOLOGY LABORATORY **I(0,3)1**
A series of laboratory exercises dealing with the preparation, isolation and characterization of antigens, antibodies and effector cells. Semester project required.

Interdisciplinary Biology (Course Prefix: 82)

Courses of an interdisiplinary nature exploring areas resulting from the interaction of biological science with other fields—academic, professional, or practical.

82-351 HUMAN SEXUALITY **I,II(3,0)3**
The biological, psychosocial and attitudinal aspects of human sexuality are addressed through lectures, discussions, films and from a variety of perspectives. Three lecture-discussions per week.

82-354 WILDLIFE AND ENVIRONMENTAL MANAGEMENT **II(3,0)3**
An introduction to some of the concepts and principles applicable to forest and wildlife utilization. Esthetic and economic considerations will be discussed and serve as the basis for oral and written presentations. Practical experiences in the laboratory and the field such as census methods, tree classification and skinning methods will supplement lecture material. Prerequisite: An ecology course or permission of instructor.

82-551 HUMAN SEXUALITY: CURRENT PERSPECTIVES **(3,0)3**
The biological, psychosocial, and attitudinal aspects of human sexuality are dealt with from a variety of perspectives. This course is designed to serve the needs of biologists, teachers, counselors, health professionals, and others concerned with the applied aspects of the subject. By arrangement.

Life Sciences (Course Prefix: 83)

Courses designed primarily to service the needs of students who are not majoring or minoring in biological science. Although these courses may not ordinarily be used for degree credit for students majoring in biological sciences, they may be used as electives for others and may be used to satisfy University core requirements.

83-101 LIFE SCIENCE I **I,II(3,0)3**
An introduction to the study of biology which considers the earth's environment as a community in which plants and animals live and interact. Corequisite: 83-103.

83-102 LIFE SCIENCE II **I,II(3,0)3**
The emphasis in this course will be on systems structure and function. The cellular organization of plants and animals will lead into physiological processes of higher organisms including nutrition and digestion, cellular metabolism, circulatory, respiratory, excretory, nervous, reproductive and musculo-skeletal systems. Hormonal control and immunity will also be considered. Among the topics covered are: chemistry relating to life processes, genetics which covers human inheritance as well as DNA replications, transcription and mutagenesis. Also covered is behavior, evolution, and ecology.

83-103 LIFE SCIENCE LABORATORY I **I,II(0,2)1**
Laboratory work associated with 83-101. Corequisite: 83-101.

83-104 LIFE SCIENCE LABORATORY II **I,II(0,2)1**
Laboratory work associated with 83-102.

83-122 THE PLANT AND YOU **I(3,0)3**
A humanistic approach to botany emphasizing the interrelationships between plants, people, and human civilization. Plant structure and function, and aspects of genetics, evolution and ecology will be included. In the laboratory and greenhouse, students will explore the interrelationships between function, structure and environment in plants.

83-123 NUTRITION AND DISEASE **I(3,0)3**
This is an interdisciplinary, survey course for students not majoring in biology which deals with human nutrition as it relates to various chronic disease states. Methods of detection and treatment of the disorders will be considered as well as general concepts of health promotion/disease prevention. Specific topics covered include the role of nutrition in: heart disease, diabetes, alcoholism, obesity, senility-geriatrics, gallbladder disease, cancer, anorexia nervosa-bulimia, and pregnancy. Parenteral nutrtion will also be discussed.

83-126 HUMAN DISEASE AND IMMUNITY **II(3,0)3**
An introductory course for students not majoring in biology, dealing with the immune response of the human body to selected viral, bacterial, parasitic, cancerous, allergic and autoimmune factors of disease. The influence of aging, alcohol, drugs, nutrition, and smoking on the response will be discussed.

83-128 THE MICROBIAL PERSPECTIVE **II(2,0)2**
This is an introductory survey course for students not majoring in biology and with no formal science background. This course deals with the basic principles of microbiology as related to the study of biology and the interrelationships that develop between microorganisms and other life forms, particularly man. Disease interactions, antimicrobial actions, microbial ecology, food microbiology, commercial applications, and genetic engineering will be topics of lecture and discussion.

83-129 THE MICROBIAL PERSPECTIVE – A LABORATORY EXPERIENCE **I(0,2)1**
This course will introduce simple laboratory techniques that are basic to microbiological procedures. Investigative techniques will be employed later as they relate to the discussions of lecture portion of the course. Corequisite: 83-128.

DEPARTMENT OF CHEMISTRY

Samuel P. Sawan, Chairperson

Professors: William Bannister, Eugene Barry, Alexandre Blumstein, Rita Blumstein, Stuart Clough, Stanley Israel, Philip Lamprey, Robert Peirent, James Pierce, Chong Pyun, Harry Rubinstein, Joseph Salamone, Samuel Sawan, Ruth Tanner, Arthur Watterson, Shan S. Wong.

Associate Professors: Sabino Caputo, Don Hilton, Martin Isaks, Edwin Jahngen, Judith Kelley, Albert Kowalak, Kuang-Pang Li, Irving Lipschitz, Kenneth A. Marx, Melisende McDonald, Sukant Tripathy.

Assistant Professors: Terrence Tougas.

The Department of Chemistry strives to make its programs current by a continuous re-evaluation by its faculty members and its consumers. An outside advisory board of industrial and academic chemists has been established to meet periodically with and advise the department on all aspects of its academic programs.

Chemistry Major

Chemistry is both a basic and an applied science and, as such, is fundamental not only to an understanding of the structure, properties, and reactions of matter, but also to comprehension of the very nature of twentieth-century civilization. Career opportunities in chemistry are as many and as varied as are the applications of chemistry to contemporary life and include, by way of example, applied and basic research, product analysis, manufacturing, and marketing. Completion of the chemistry curricula also provides preparation for all areas of the chemical profession as well as for graduate study in chemistry, dentistry, medicine, and teaching.

Both the Bachelor of Arts and the Bachelor of Science degree programs have been approved by the Committee on Professional Training of the American Chemical Society, and program options and course offerings are designed to meet the latest recommended standards. However, program options permit students to graduate as chemistry majors without meeting all the requirements of the American Chemical Society. In such cases, a degree is not approved by the society. Major programs of the Bachelor or Arts and Bachelor of Science degrees include required courses which supply a thorough grounding in basic chemistry principles and techniques and provide flexible requirement options in areas of analytical chemistry, biochemistry, environmental chemistry, inorganic chemistry, organic chemistry, physical chemistry, radiochemistry, and polymer chemistry. Chemistry programs also permit the incorporation of specialized laboratory or research courses which provide up-to-date knowledge concerning the utilization of such sophisticated instrumentation as atomic absorption spectroscopy, electron microscopy, gas liquid chromatography, nuclear magnetic resonance spectroscopy, and x-ray spectroscopy.

The Bachelor of Arts curriculum offers the student who is interested in such fields as chemical journalism or literature, illustrative arts (e.g., chemical graphics and illustrations), languages (technical translating), social sciences and the humanities with the opportunity to elect a major in chemistry while also pursuing options in areas of the humanities and social sciences. The Bachelor of Arts Curriculum is also an appropriate program for students who are interested in preparing for teaching at the secondary school level and wish to pursue a graduate program in education. Although the curriculum of the Bachelor of Science degree is generally elected by students who are interested in professional careers in chemistry fields, the curriculum of the Bachelor of Arts degree is an equally appropriate choice for such students, especially when it is completed in accordance with requirements of the American Chemical Society.

The chemistry program is a flexible program of requirements which allows each student to select advanced courses according to his or her interests and goals and to pursue studies which combine proficiency in chemistry with training in such fields as business administration, biological sciences, biochemistry, mathematics, chemical engineering, electrochemistry, radiochemistry, materials science, chemical energy, and polymer chemistry. Courses in physics, mathematics, languages, social science, and literature serve to support the chemistry courses and to prepare the student to interact effectively in both social and professional settings.

American Chemical Society approved programs require a total of 400 hours or the equivalent of traditional classroom work and a total laboratory experience of not less than 500 hours.* An allowance of 100 hours maximum may be given for laboratory work associated with independent laboratory research. In addition to the chemistry core noted, ACS approved programs require a course in advanced inorganic chemistry plus a minimum of 6 semester hours of advanced work. Advanced chemistry courses are those having a major portion of the core curriculum as a prerequisite. Upper level independent study and research at the post-physical chemistry level may be counted as advanced work, as may be Chemistry Department approved advanced courses in chemical engineering, computer science, geochemistry, mathematics, molecular biology, physics and other allied fields. Because of the importance of biochemistry and polymer chemistry, these areas are particularly recommended as advanced courses.

Cooperative Education Program

The Department of Chemistry has formally adopted the voluntary University Cooperative Education Work Experience Program. This program is designed to combine chemistry-oriented work experience in industrial or related laboratories with opportunities to earn an income. The department schedules the student to start the off-campus program after the completion of four semesters of academic work, which must include the successful completion of one year of organic chemistry and one semester of physical chemistry. Co-Op I begins in the summer session of the second year. Co-Op II begins in the spring semester of the third year. Co-Op III begins in the fall semester of the fifth year. Up to six University elective credits may be granted for the co-op program. The student will sign a contract outlining the co-op experience and requirements. For further information concerning the Cooperative Education Program, consult University policies which appear elsewhere in this publication under the heading of "Academic Policies: Cooperative Education".

Financial Support for Chemistry Majors

In addition to the usual financial resources for undergraduates, the department has special scholarships totaling over $7,400 available to its students together with awards for outstanding achievement. The major scholarships and awards are:

Roland E. Derby Memorial Scholarship
Russell Weeks Hook Scholarship
Paul C. Panagiotakos Scholarship
Allen Scattergood Scholarship
Allen Scattergood Summer Fellowship
American Institute of Chemists Annual Award
Louis A. Olney Book Prizes

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* The required chemistry core provides 420 hours of classroom work and 434 hours of laboratory.

Chemistry Department Award
Chemistry Textbook Awards

The department has also employed several of its majors as graders and laboratory aides. Funded research projects have, on occasion, employed exceptional undergraduates.

Chemistry Awards

Freshman Chemistry Award: The CRC Handbook of Chemistry and Physics is given to the freshman student in chemistry who shows the greatest achievement in chemistry.

Louis A. Olney Book Prizes: Stipends of $80, $100, and $150 are awarded each spring respectively to a sophomore, junior, and senior chemistry major. Awards are based solely on scholastic achievement.

American Chemical Society Affiliate Chapter Award: An award is presented annually by the ACS student affiliate chapter to the outstanding senior majoring in chemistry or chemical engineering based upon academic performance and demonstration of research capability.

American Institute of Chemists Annual Award: This award is presented by the American Institute of Chemists and is given in recognition of potential advancement of the chemical profession on the basis of a student's demonstrated record of leadership, character, and scholastic achievement. It is presented to a senior and consists of an embossed certificate bearing the name of the student, school, and year. A one-year Student Associate membership in AIC and a subscription to The Chemist is also presented.

Chemistry Department Award: This award is funded by the College and is given to an outstanding senior for scholastic achievement, leadership, character, and service to the students in the Department of Chemistry and the College of Pure and Applied Science. The award varies depending on the academic interests of the recipient.

Chemistry Scholarship and Loan Programs

Roland E. Derby, Sr., Memorial Scholarship: Three scholarships are awarded each year to chemistry majors, one in each of the sophomore, junior, and senior classes. It is granted on the basis of scholarship and financial need. The stipend is $500 per year and is renewable for recipients in good academic standing.

Russell Weeks Hook Scholarship: Six scholarships are awarded each year to two chemistry majors in the sophomore, junior, and senior classes. This scholarship is granted on the basis of scholarship and financial need. The stipend is $400 per year and is renewable for recipients in good academic standing.

Paul C. Panagiotakos Scholarship: A $500 scholarship is awarded each year to an outstanding chemistry major in memory of Dr. Paul C. Panagiotakos, a former faculty member and chairman of the organic chemistry group. The recipient is chosen on the basis of scholarship and financial need, with preference given to students interested in pursuing a career in organic chemistry.

Allen Scattergood Scholarship Awards: These scholarships are funded from the Allen Scattergood Trust Fund, established in memory of former organic chemistry Professor Allen Scattergood. Three full tuition scholarships are awarded yearly to the top ranking chemistry major in each of the three upper classes. The recipients are chosen by the scholarship committee upon review of the previous year's academic records of all chemistry majors. The award is in the amount of one year's in-state tuition and therefore is subject to change.

Summary Of Degree Requirements

1. University Core Requirements

Physical Education	2
English Composition (42-101, 42-102)	6
Area I—Behavioral and Social Sciences	6-12*
Area II—Fine Arts and Humanities	6-12*
Area III—Mathematics and Sciences	9-11**
Human values requirement	3

2. Major Field Requirements

A. Chemistry	**38**
84-121 Chemistry	3
84-123 Chemistry Laboratory	1
84-122 Chemistry	3
84-124 Chemistry Laboratory	1
or	
84-135 Honors Chemistry	3
84-137 Honors Chemistry Laboratory	1
84-136 Honors Chemistry	3
84-138 Honors Chemistry Laboratory	1
84-207 Inorganic Chemistry	3
84-209 Inorganic Chemistry Laboratory	2
84-221 Organic Chemistry IA	3
84-227 Organic Chemistry Laboratory I	1
84-222 Organic Chemistry IIA	3
84-228 Organic Chemistry Laboratory II	1
84-260 Information Retrieval	1
84-313 Analytical Chemistry I	3
84-315 Analytical Chemistry I Laboratory	1
84-314 Analytical Chemistry II	3
84-316 Analytical Chemistry II Laboratory	1
84-344 Physical Chemistry I	3
84-346 Physical Chemistry I Laboratory	1
84-345 Physical Chemistry II	3
84-350 Physical Bioinorganic Chemistry Laboratory	2
84-360 The Responsible Chemist	2

Note: ACS approved programs require 84-334, advanced inorganic chemistry, plus a minimum of 6 semester hours of advanced courses—see the discussion of ACS requirements above. Not more than 45 credits in chemistry may be credited to the minimum B.A. requirements of 126 credits and not more than 60 credits in chemistry may be credited to the minimum B.S. requirements of 126 credits.

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* A minimum of two courses and six semester credits must be presented in each of Area I and Area II plus two additional courses (six semester credits) selected from either or both of these areas Total: six courses, eighteen semester credits.

** Chemistry majors are exempted from Area III requirements

B. Supporting Sciences and Mathematics

1. For Bachelor of Science Degree	23
95-201 Principles of Physics I	3
96-103 General Experimental Physics I	1
95-202 Principles of Physics II	3
96-104 General Experimental Physics II	1
92-131 Calculus I	4
92-132 Calculus II	4
92-231 Calculus III	4
or	
92-133 Honors Calculus I	4
92-134 Honors Calculus II	4
92-233 Honors Calculus III	4
92-234 Differential Equations	3
or	
92-386 Statistics for Engineering and Science	3

All B.S. Chemistry majors must display facility in a computer language other than COBOL by one of the following means:

a. Achievement of a proper grade in the E.T.S. exam in PASCAL.
b. Passing a one semester University introductory course in a computer language other than COBOL.
c. Passing a Mathematics department challenge exam in an introductory computer language other than COBOL.
d. Passing an advanced University course in a computer language other than COBOL.

All interpretations of the above, such as a "proper" grade in the E.T.S. exam or what courses will satisfy the requirement, will be made by the Chemistry Department Undergraduate Policy Committee.

2. For Bachelor of Arts Degree	26-28
95-201 Principles of Physics I	3
96-103 General Experimental Physics I	1
95-202 Principles of Physics II	3
96-104 General Experimental Physics II	1
92-131 Calculus I	4
92-132 Calculus II	4
92-231 Calculus III	4
or	
92-133 Honors Calculus I	4
92-134 Honors Calculus II	4
92-233 Honors Calculus III	4
Two additional Science courses exclusive of Mathematics and Chemistry	6-8

C. Each B.S. chemistry student is required to take two semesters (6 credits) of a foreign language at the introductory level or one semester (3 credits) at the intermediate or advanced level.

3. Program options and electives

A. For Bachelor of Science Degree

Since the Bachelor of Science degree is meant to provide a broad educational experience as well as specialized training in chemistry, a minimum of 62 credits (including physical education) must be taken outside of chemistry. This requirement is met through the core, the physics, mathematics, and computer requirements, and electives. Also, since the Bachelor of Science required chemistry plus other College of Pure and Applied Science courses total 15-16 courses and 61-64 credits, depending on whether or not a computer course is taken, additional courses must be elected from the offerings of the college to meet the requirements of 20 courses and 74 credits. B.S. Chemistry students, in consultation with their advisors, are encouraged to consider not only advanced courses in chemistry, but courses and minors which develop their knowledge and talents in the other sciences, mathematics, engineering, and the management sciences.

B. For Bachelor of Arts Degree

Since the Bachelor of Arts degree is meant to provide a broad, comprehensive education, a minimum of 75 credits must be taken outside of chemistry. This requirement is met through the core, the physics and the mathematics requirements, and electives. A minimum of 27 credits (in addition to Area I and Area II) must be taken from course offerings of the College of Liberal Arts, the College of Music, and the Economics offerings of the College of Management Science. These courses are selected by students in accordance with their needs, interests, and talents, and in the consultation with faculty advisors. Minor areas of study may be selected in the College of Liberal Arts. A minor in economics may also be selected in the College of Management Science.

4. Minimum Credit Requirements (including Physical Education) 122*

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* Courses which are prerequisites for physics, chemistry, and mathematics courses of the Major Field Requirements, or courses which are prerequisites for admission to the College of Pure and Applied Sciences, may not be credited to requirements for a baccalaureate degree in chemistry.

SAMPLE COURSE OF STUDY FOR CHEMISTRY (Bachelor of Science)

The course of study for the Bachelor of Arts program omits those courses marked with *. The choice of electives selected for each of the degree programs is guided by the major field requirements specified above, and by the student's interests.

Freshman Year

Fall Semester		Spring Semester	
84-121 Chemistry I	3	84-122 Chemistry II	3
84-123 Chemistry I Lab	1	84-124 Chemistry II Lab	1
95-201 Principles of Physics	3	95-202 Principles of Physics	3
96-103 Gen'l. Exp. Physics I	1	96-104 Gen'l. Exp. Physics II	1
92-131 Calculus I	4	92-132 Calculus II	4
42-101 College Writing	3	42-102 College Writing & Lit.	3
39- Physical Education	1	39- Physical Education	1
	16		16

Sophomore Year

Fall Semester	
84-221 Organic Chemistry I-A	3
84-227 Organic Chem. Lab	1
84-207 Inorganic Chemistry	3
84-209 Inorganic Chem. Lab	2
92-231 Calculus III	4
Language*	3
	16

Spring Semester	
84-222 Organic Chemistry II-A	3
84-228 Organic Chem. Lab	1
84-344 Physical Chemistry I	3
84-346 Physical Chem. Lab I	1
92-386 Statistics For Engineering and Science*	3
84-260 Information Retrieval	1
Language*	3
Elective	3
	15-18

Junior Year

Fall Semester	
84-313 Analytical Chemistry I	3
84-315 Analytical Chem. Lab	1
84-345 Physical Chemistry II	3
84-350 Phys. Bioinorganic Chem. Lab	2
Electives	6-9
	15-18

Spring Semester	
84-314 Analytical Chemistry II	3
84-316 Analytical Chem. Lab	1
Electives	12-14
84-360 The Responsible Chemist	2
	18-20

Senior Year

Fall Semester	
Electives	14-16

Spring Semester	
Electives	14-16

Chemistry Minor

A minor in chemistry consists of 18-24 credits in chemistry, exclusive of any course work taken to satisfy the area III requirement. All course prerequisites must be satisfied. The course requirements for the chemistry minor are as follows:

a. A freshman level course (84-121,123, and 84-122,124) or the equivalent must be included.
b. Beyond the required freshman level course, four additional courses are required, of which not more than two may be from the same chemistry area.
c. At least two courses must carry a laboratory component (exclusive of 84-121, 123 and 84-122,124 or its equivalent).
d. A lecture course with a corequisite laboratory course will be considered as one course of the additional course requirement.
e. At least eight semester hours must be taken at or above the 300 course level, and of these courses, at least 3 credits must be in a chemistry course or courses not required by the curriculum of the student's department.

Chemistry (Course Prefix: 84)

84-101 APPLIED CHEMISTRY FOR NON-SCIENTISTS I(3,0)3

Focusing on the particle nature of matter, this course delineates the structures of atoms, molecules and ions and how these structures account for the properties of inorganic and organic substances. The emphasis is on the student's acquiring the knowledge and reasoning skills to apply these theories to understanding topics such as nuclear chemistry, pollution, and the production and uses of energy and of natural and man-made substances (e.g. vitamins, drugs, semi-conductors). Demonstrations and hands-on opportunities are provided as aids in learning the scientific method for developing knowledge. This course meets the Area III core requirements.

84-111 GENERAL CHEMISTRY I **I(3,0)3**
A one semester survey of the chemistry principles which govern the structure of matter, the quantitative and qualitative aspects of compounds and chemical reactions, properties of matter, periodicity, solution chemistry including acid-base chemistry, reaction rates, equilibrium, and oxidation-reduction. Corequisite 84-113. Note: This is not an appropriate course for students in the College of Pure and Applied Science (See 84-121 and 84-122).

84-112 GENERAL CHEMISTRY II **II(3,0)3**
A survey of the basic principles of organic chemistry and biochemistry with emphasis on biochemical aspects of carbohydrates, lipids, proteins and nucleic acids. Various metabolic pathways are also emphasized. Primarily for nursing majors. Prerequisite: 84-111 or by permission of instructor. Corequisite: 84-114.

84-113 GENERAL CHEMISTRY LABORATORY I **I(0,3)1**
This laboratory courses is the corequisite of 84-111. Experiments emphasize the principles covered in 84-111 and the techniques, skills and reasoning employed in the scientific method.

84-114 GENERAL CHEMISTRY LABORATORY II **II(0,3)1**
Laboratory experiments designed to illustrate the principals discussed in 84-112. Prerequisite: 84-113 or permission of instructor. Corequisite: 84-112.

84-115 ART IN CHEMISTRY **I(2,2)4**
Selected fundamental chemical principles are discussed and illustrated by demonstrations and student experimentation. Themes for discussion are the nature of color, and the structure and reactivity of common materials and chemical events of daily experience. This course meets the Area III core requirements.

84-121 CHEMISTRY I **I(3,0)3**
An introduction to the basic concepts of chemistry. Topics include chemical calculations, atomic structures, the periodic table, basic bonding theory, solutions, liquids, gases. Corequisite: 84-123.

84-122 CHEMISTRY II **II(3,0)3**
A continuation of 84-121. Topics include thermodynamics, kinetics, acids and bases, introduction to organic chemistry, chemical equilibrium, precipitation reactions, electrochemistry. Prerequisite: 84-121. Corequisite; 84-124.

84-123 CHEMISTRY LABORATORY **I(0,3)1**
An experimental study of chemical principles and chemical transformation that is coordinated with topics considered in 84-121. Some of the more important reactions of elements, oxides, acids, bases and salts are examined. Other topics include chemical separation, purification, preparation of inorganic salts; quantitative determinations dealing with the formula of a compound, gas laws, and colligative properties are performed. Careful technique and precise measurements are stressed. Corequisite: 84-121.

84-124 CHEMISTRY LABORATORY **II(0,3)1**
A continuation of the laboratory study begun in 84-123 that is coordinated with topics of 84-122. Topics include: thermochemistry, kinetics, spectroscopy, titration, pH, equilibrium reaction and constant. Some aqueous solution reactions and organic reactions are examined. Accurate measurements and precise instrumental and apparatus operation are expected. Corequisite: 84-122.

84-135 HONORS CHEMISTRY **I(3,0)3**
A course designed for capable students. Periodic relationships and principles of stoichiometry, chemical structure, and states of matter are used to characterize the nature of chemical substances. The chemical reactions of certain inorganic substances are considered. Students are encouraged to contribute ideas, question concepts, and participate in discussion. Prerequisite: invitation or permission of instructor. Corequisite: 84-137.

84-136 HONORS CHEMISTRY **II(3,0)3**
A continuation of 84-135. States of matter, thermodynamics, solution phenomena, chemical kinetics, chemical equilibrium, electrochemistry, and acid-base phenomena are used to characterize the chemical reactions of both organic and inorganic substances. Students are encouraged to participate in the discussion of course material. Prerequisite: 84-135 or permission of instructor. Corequisite: 84-138.

84-137 HONORS CHEMISTRY LABORATORY **I(0,3)1**
A series of laboratory experiments designed to illustrate the principles discussed in 84-135 and to train the student in the techniques of experimentation. Prerequisite: invitation or permission of instructor. Corequisite: 84-135.

84-138 HONORS CHEMISTRY LABORATORY **II(0,3)1**
A series of laboratory experiments designed to illustrate the principles discussed in 84-135 and train the student in the techniques of experimentation. Prerequisite: 84-135 and 84-137. Corequisite: 84-136.

84-207 INORGANIC CHEMISTRY **I(3,0)3**
The chemical behavior, structure, and methods of preparation and nomenclature of the more common elements and their compounds. Prerequisite: 84-122, 84-124, or 84-136, 84-138. Corequisite: 84-209.

84-209 INORGANIC CHEMISTRY LABORATORY I **I(1,3)2**
A computation and laboratory course with the purpose of obtaining increased experience with equilibrium calculations, to study the reaction chemistry of ions in aqueous solution, and to carry out inorganic syntheses and characterizations. Prerequisite: 84-122. Corequisite: 84-207.

84-220 ORGANIC CHEMISTRY LABORATORY PRINCIPLES **I(0,4)1**
The course consists of a brief survey of organic laboratory techniques, which are used in selected organic chemistry reactions. Some instrumental methods are demonstrated. For CN majors only. Corequisite 84-222.

84-221 ORGANIC CHEMISTRY IA **I(3,0)3**
The basic principles and reactions which characterize the behavior of carbon compounds. Nomenclature and mechanism of reaction of many classes of chemical species will be covered. Emphasis is on broad aspects of theory by which the facts of organic chemistry can be deduced. Primarily for chemistry and biology majors. Prerequisite: 84-122 or 84-136. Corequisite: 84-227 or 84-229. Required for chemistry majors.

84-222 ORGANIC CHEMISTRY IIA **II(3,0)3**
A continuation of 84-221. Required for chemistry majors. Prerequisite: 84-221. Corequisite: 84-220 or 84-228 or 84-230.

84-223 ORGANIC CHEMISTRY IB **I(3,0)3**
Discussions of the chemistry of organic compounds with emphasis on nomenclature, synthesis, reactions and reaction mechanisms, and applications of these in situations of laboratory, biological and industrial importance. An introduction to basic principles of polymer chemistry will be included. Primarily for, but not limited to, plastics engineering students. Prerequisite: 84-122 or 84-136. Corequisite: 84-225 or permission of instructor.

84-224 ORGANIC CHEMISTRY IIB **II(3,0)3**
A continuation of the first semester subject 84-233. Prerequisite: 84-223. Corequisite: 84-226 or permission of instructor.

84-225 ORGANIC CHEMISTRY LABORATORY IB **I(0,4)1**
Laboratory work in this course is scheduled to accompany topic presentations in the lecture phase of the course (84-223), with emphasis on organic laboratory techniques, equipment and procedures. Corequisite: 84-223.

84-226 ORGANIC CHEMISTRY LABORATORY IIB **II(0,4)1**
A continuation of the first semester laboratory course, 84-225. Prerequisite: 84-225. Corequisite: 84-224.

84-227 ORGANIC CHEMISTRY LABORATORY I **I(0,4)2**
Laboratory work designed to emphasize the techniques of organic synthesis and the use of instrumentation for identification and characterization of organic compounds. Required for chemistry majors. Prerequisite: 84-124 or 84-138. Corequisite: 84-221.

84-228 ORGANIC CHEMISTRY LABORATORY II **II(0,4)2**
A continuation of 84-227 with emphasis on planning and successfully carrying out reactions published in the chemical literature. Required for chemistry majors. Prerequisite: 84-227. Corequisite: 84-222.

84-229 ORGANIC CHEMISTRY LABORATORY IA **I(0,4)1**
Techniques, skills and heuristic approaches in the synthesis, purification, and identification of organic compounds. IR, GC, and NMR instrumental methods included. Corequisite: 84-221.

84-230 ORGANIC CHEMISTRY LABORATORY IIA **II(0,4)1**
A continuation of 84-229. Prerequisite: 84-229. Corequisite: 84-222.

84-252 NUTRITION **I(3,0)3**
A study of the science of food, the nutrients and other substances therein, their action, interaction and balance in relation to health and disease and the chemical processes by which the nutrients are digested, absorbed, transported, and utilized to maintain good health. Prerequisite: 84-112 or 35-252.

84-260 INFORMATION RETRIEVAL **II(1,0)1**
Techniques and skills required for the use of electronic information tools. Required for the class of 1990. Normally taken in sophomore year.

84-300 DIRECTED STUDIES IN CHEMISTRY I **II(0,3-6)1**
An introduction to techniques of research. Open only to chemistry majors. Credit does not count toward those for A.C.S. certification nor toward the total of 122 credits for graduation. Prerequisite: 4 semesters of college level chemistry with laboratory, and permission of instructor.

84-313 ANALYTICAL CHEMISTRY I **I(3,0)3**
This course will focus on the evaluation of analytical data, aqueous and non-aqueous acid-base systems, oxidation reduction and complexation equilibria, solubility and precipitation, solvent extraction, ion-exchange and chromatographic methods. Prerequisite: 84-344. Corequisite: 84-315.

84-314 ANALYTICAL CHEMISTRY II **II(3,0)3**
The course will introduce the student to modern instrumental methods of chemical analysis.

Included are such topics as ultraviolet-visible and infrared, emission and atomic absorption spectroscopy. The principles and applications associated with mass spectrometry, thermal and electrochemical methods of analysis, chromatographic techniques such as GC and HPLC will also be presented. This course is required for chemistry majors and is strongly recommended for students in the M.S. and Ph.D. programs in environmental studies with permission of the instructor. Prerequisite: 84-313, and 95-202. Corequisite: 84-316.

84-315 ANALYTICAL CHEMISTRY I LABORATORY I(0,4)2
Experiments emphasizing the topics presented in 84-313 will be conducted. Corequisite: 84-313.

84-316 ANALYTICAL CHEMISTRY II LABORATORY II(0,4)2
Laboratory experiments are designed to complement the coverage of topics in 84-314. Prerequisites: 84-313, 84-315. Corequisite: 84-314.

84-321 ADVANCED ORGANIC LABORATORY I(I,6)3
This course involves more advanced laboratory work in organic chemistry using modern techniques of synthesis. Instrumentation and chemical methods are used to identify reaction products as well as unknown compounds. Prerequisite 84-222 or 84-224.

84-324 PRINCIPLES OF ANALYTICAL CHEMISTRY I or II(3,0)3
This course is designed to introduce engineering and science (other than chemistry) majors to the theory of gravimetric, volumetric, spectroscopic, and chromatographic analysis. Not open to students who have taken 84-314, 84-316, 84-313, or 84-315. Prerequisites: 84-122 or 84-136, and 92-131. Corequisite: 84-325.

84-325 PRINCIPLES OF ANALYTICAL CHEMISTRY LABORATORY I or II(0,4)1
The laboratory work is designed to parallel the lecture topics in 84-324, with a particular emphasis on practical and applied conventional analytical analysis such as gravimetric, titrimetric, and spectroscopic analysis. Prerequisite: 84-124 or equivalent. Corequisite: 84-324.

84-330 INTRODUCTORY BIOCHEMISTRY II(3,0)3
An introductory study of the fundamental principles of biochemistry including the chemistry of proteins, carbohydrates, nucleic acids and lipids, thermodynamics, kinetics and mechanisms of enzyme action, intermediary metabolism and selected topics in molecular biology. Prerequisites: 84-222, 84-344 or permission of instructor.

84-332 INTRODUCTORY BIOCHEMISTRY LABORATORY II(0,6)2
Laboratory experiments designed to acquaint the students with modern techniques in biochemistry and to emphasize material covered in 84-330. Prerequisite or corequisite: 84-330, or permission of instructor.

84-334 ADVANCED INORGANIC CHEMISTRY II(3,0)3
An introduction to modern theories of atomic structure and chemical bonding, with emphasis on physical-chemical principles and properities. Considerable time will be spent on coordination compounds including topics such as descriptive chemistry, biochemical importance, and ligand field theory. Prerequisite: 84-345.

84-339 PHYSICAL CHEMICAL PRINCIPLES I or II(3,0)3
A one-term course designed for plastics technology majors. Emphasis is on aspects of physical chemistry of importance to polymer science: thermodynamics, solutions, kinetics, and optical methods of analysis. Prerequisites: 84-122 or 84-136, 92-231 or 92-233.

84-341 PHYSICAL CHEMICAL PRINCIPLES LABORATORY I or II(0,3)1
Laboratory work designed to exemplify principles and applications covered in 84-339. Corequisite: 84-339.

84-342 ORGANIC QUALITATIVE ANALYSIS **I or II(I,6)3**
Methods of identification and characterization of unknown organic substances whose properties have been previously published in the chemical literature. Prerequisite: 84-222 or 84-224.

84-344 PHYSICAL CHEMISTRY I **I or II(3,0)3**
The 84-344-345 sequence covers basic physical chemical topics: laws of thermodynamics, solutions, chemical and phase equilibria, electro-chemistry, kinetics, and atomic and molecular structure. Required for chemistry majors. Prerequisites: 92-231 or 92-233, 84-122 or 84-136.

84-345 PHYSICAL CHEMISTRY II **I or II(3,0)3**
A continuation of 84-344, Required for chemistry majors. Prerequisite: 84-344.

84-346 PHYSICAL CHEMISTRY LABORATORY I **I or II(0,4)2**
Laboratory work designed to exemplify principles covered in 84-344. Prerequisite: 84-124 or 84-138. Corequisite: 84-344. Required for chemistry majors.

84-347 PHYSICAL CHEMISTRY LABORATORY II **I or II(0,3)1**
Laboratory work designed to exemplify principles of chemical kinetics, equilibrium and spectroscopy. Prerequisite: 84-346. Corequisite; 84-345.

84-350 PHYSICAL BIOINORGANIC CHEMISTRY LABORATORY **I(I,3)2**
Coordination compounds are utilized in a core of experiments to illustrate basic physiochemical techniques and analysis of experimental data in electrochemistry and kinetics. A project lab is carried out to apply and extend techniques learned. Prerequisites: 84-344 and 84-346 or other laboratory experience in thermodynamics. Corequisite: 84-345.

84-360 THE RESPONSIBLE CHEMIST **II(2,0)2**
Exploration of the ethics and values associated with the practice of chemistry. Required as a standard IV core requirement. Open to juniors and seniors only.

84-402 COLOR SCIENCE **I(2,3)3**
An analytical course in which the concepts and methods of absorption and reflectance spectrophotometry are applied to the measurement of color perception, color difference, and the prediction of color matching. Encompasses both theoretical and applied practical methods for determining both qualitative and quantitative composition of the color producing components in transparent and opaque substratum such as liquids, paper, plastics, and textiles. Instrumental and computer usage for measuring and calculating trichromatic coefficients, color differences and color matching formulations are employed. Prerequisites: 84-313 and 84-222, or 84-224; permission of instructor.

84-403 INTRODUCTORY POLYMER SCIENCE I **I(3,0)3**
An introduction to the physical chemistry of polymers, including molecular weight distribution and averages, polymer solutions, fractionation, methods of molecular determination, and structure and properties in the rubbery, glassy and crystalline states. Prerequisites: 84-222 or 84-224, 84-345 or 84-339.

84-404 INTRODUCTORY POLYMER SCIENCE II **II(3,0)3**
Step and chain growth polymerizations. Kinetics and mechanism. Copolymerization. Ionic and free radical polymerizations. Industrially important polymers. Prerequisites: 84-222 or 84-224, 84-345 or 84-339.

84-405 POLYMER LABORATORY I **II(0,4)1**
An introductory laboratory in polymer science concerned with the physical and chemical characterization of polymers. Prerequisites: 84-222 or 84-224, 84-345 or 84-339.

84-406 POLYMER LABORATORY II **II(0,4)1**
An introductory laboratory in polymer science concerned with the techniques of polymer synthesis. Prerequisites: 84-222 or 84-224, 84-345 or 84-339.

THESES

Credit for undergraduate thesis in chemistry (84-407-408) may be used by chemistry majors for credit and as a chemistry elective only when the thesis is under the direction and direct supervision of a member of the chemistry faculty. Interdisciplinary research may be used for chemistry credit only when the thesis is under the direct supervision of a member of the chemistry faculty, such that the second department involved is in an advisory role or supportive role. When those roles are reversed, or when research is done principally or totally under the direction of a faculty member of another department, the undergraduate research must be taken under the auspices of the other department involved, using the corresponding undergraduate research course numbers for that department. The course may then be used as a general elective in the chemistry major program. However, only six credits in any undergraduate research experience will be applied to an academic program in chemistry for the minimum graduation credit. In the case of interdisciplinary research, where one semester is to be done in another department, a total of six credits for the year may be counted toward graduation with the stipulation that the second semester of research is a continuation of the first semester. In this special case, the student would be receiving three chemistry credits and three elective credits for undergraduate research.

84-407 UNDERGRADUATE THESIS I **I(0,9-12)3**
Research in biochemistry, electrochemistry or analytical, organic, inorganic, physical, or polymer chemistry. Progress report required. Prerequisite: permission of department chairperson and thesis supervisor. For credit for ACS certification, 84-407 must be followed by 84-408.

84-408 UNDERGRADUATE THESIS II **II(0,9-12)3**
A continuation of 84-407. Both semesters must be taken and not more than six credits may be used in meeting degree requirements. A written thesis and seminar are required. The written thesis is to follow the conventional form of introduction, literature survey, data, results, and conclusions. One copy of the thesis must be filed in the department office. Prerequisite: permission of department chairperson and thesis supervisor.

84-423 ADVANCED ORGANIC CHEMISTRY **I(3,0)3**
Extension of introductory organic chemistry. Organic reactions and compounds are discussed in terms of reaction mechanisms, structure-reactivity and stereochemistry. Prerequisite: 84-222 or 84-224.

84-424 ADVANCED ORGANIC CHEMISTRY **II(3,0)3**
Synthesis of organic molecules. Selected reagents and techniques are discussed with emphasis on the scope and limitations of these reactions. The reaction mechanisms are also discussed. Prerequisite: 84-423 or permission of instructor.

84-426 BIOINORGANIC CHEMISTRY **II(2,0)2**
An introduction to the role of metal ions in biological processes. Properties of metal ions will be discussed and how these contribute to a more detailed understanding of the biological systems in which they are involved. Prerequisite: 84-330 or equivalent.

84-434 COLLOID SCIENCE AND ITS ENVIRONMENTAL APPLICATIONS **II(3,0)3**
An introduction to the fundamentals of colloid and interface science. Topics discussed include solid/gas, solid/liquid, and liquid/liquid interfaces; association colloids, emulsion suspensions, aerosols and foams. Additional topics include applications of colloid science

to environmental problems, flocculation and stability, absorption and ion exchange, ultrafiltration, reverse osmosis, and electro-kinetic phenomena. Prerequisite: permission of instructor.

84-440 PROTEIN CHEMISTRY **II(3,0)3**
An advanced study of the structure, synthesis, isolation, chemical and solution properties of proteins including chemical modifications and use of enzymes in industrial applications. Prerequisite: 84-330 or permission of instructor.

84-441 NUCLEIC ACID CHEMISTRY **I(3,0)3**
An advanced study of structure, isolation, synthesis and properties of nucleic acids including DNA sequencing and recombinant DNA techniques. Prerequisite: 84-330 or permission of instructor.

84-451 CHEMISTRY OF FOSSIL FUELS-COAL AND OIL SHALE **I(3,0)3**
Topics considered include: origin of coal as interpreted from composition and chemical structure; abundance, location, and economic time scale for source depletion of each rank of çoal; processes of desulfurization, denitrogenation, peptization, gasification, liquefaction, hydrogenation, partial oxidation, catalysis, and catalytic processes for refining coal. Coal utilization and its economics will be considered at appropriate times. The nature of oil shale and its use as a source of energy and chemicals will be considered in detail. Prerequisites: 1 semester physical chemistry and 84-222 or 84-224, or permission of instructor.

84-452 CHEMISTRY OF FOSSIL FUELS-PETROLEUM AND NATURAL GASII(3,0)3
Topics considered include: origin of petroleum and natural gas, development of production and distribution technology related to contemporary events, source abundance and location, economic time scale for source depletion, refining processes, catalysis and catalytic processes, and utilization of products as fuels and chemicals. Selected chemical reactions and processes of the petrochemical industry are considered in detail. Prerequisites: 1 semester physical chemistry and 84-222 or 84-224, or permission of instructor.

84-484 ELEMENTS OF RADIOCHEMISTRY **II(2,3)3**
Chemical principles are reviewed and their applications to radioactivity are discussed. Laboratory experiments are oriented to the use of common separation procedures such as ion-exchange, isotopic precipitation and paper chromatography, for a better understanding of the role of chemistry in the study of radioisotopes. Prerequisites: 84-122 and 84-124 or 84-136 and 84-138.

Primarily for Graduate Students

All graduate courses are open to undergraduate students with permission of instructor.

84-513 SPECTROSCOPY **II(3,0)3**
A theoretical and practical interpretation of molecular spectra and an introducton to lasers and their applications to spectroscopy.

84-514 ADVANCED ANALYTICAL CHEMISTRY **I or II(3,0)3**
This course is to provide graduates and undergraduates (seniors) with an understanding of the principles and theory of analytical instrumentation. The course will be divided into three sections consisting of: a) Electronic Measurements and Transducers for Chemical Systems, b) Spectrochemical Methods, and c) HPLC Detectors, Chromatographic Quantitative and Qualitative Analysis. This course is strongly recommended for students in graduate programs in Analytical Chemistry, Environmental Studies and other areas of chemistry. Prerequisites: permission of instructor or 84-314.

84-515 CHEMICAL LITERATURE **I(I,2)2**
Use of the chemical library, journals, reference works, patents and other technical publications pertaining to chemical subjects. Exercises are given in finding, assembling and using data found in the literature. The student will also be expected to assimilate the use of automated information retrieval and conduct computer assisted literature searches. Prerequisite: permission of instructor.

84-516 ADVANCED LABORATORY TECHNIQUE **II(I,6)3**
A study of the theory and application of more advanced techniques and equipment in the preparation and purification of organic and inorganic compounds including high efficiency vacuum distillation, and hydrogenation reactions in inert atmospheres. The student will be expected to master analytical techniques which involve the "hands-on": use of i.r. nmr, glc, tlc and other instrumental methods of product identification. Prerequisites: 84-523 and permission of instructor.

84-517 GLASS WORKING **I(I,3)1**
Fundamental techniques in the preparation and assembling of glass apparatus. The student will practice the art and science of scientific glass blowing. Skill in the assembly of simple scientific glass apparatus will be stressed. Open to all students with permission of instructor.

84-519 ENVIRONMENTAL CHEMISTRY **I or II(3,0)3**
The course focuses on the following: the chemistry of the oceans, atmosphere and biosphere and source and removal mechanisms of natural and anthropogenic substances, thermodynamic and kinetic models in addition to instrumental analytical methods. Prerequisite: permission of instructor.

84-521 PHYSICAL ORGANIC CHEMISTRY **I(3,0)3**
Modern and classical methodology in the study of organic reactions. Fast reactions, linear free energy relationships, instrumental techniques, and other selected topics will be covered. Prerequisite: 84-523, 84-524 or equivalent. Offered in alternate years.

84-523 ORGANIC REACTION MECHANISMS AND STRUCTURES **I(3,0)3**
Designed to provide insight into how reactions occur and how reaction mechanisms are studied. Emphasis is placed on bonding, structure and reactivity, conformational analysis and stereoelectronic effects.

84-524 ORGANIC SYNTHESIS **II(3,0)3**
Mechanism, scope and limitations of important selected types of reactions and design of synthetic sequences. Emphasis is placed on methodology of synthesis and current literature. Prerequisite: 84-523 or permission of instructor.

84-526 THEORY AND APPLICATIONS OF CHROMATOGRAPHY **I or II(3,0)3**
Coverage directed to the performance of packed and capillary column for gas chromatography and HPLC. Modern injection, detector and pumping systems used in chromatography are also discussed. Prerequisite: permission of instructor.

84-527 STEREOCHEMISTRY **I(3,0)3**
The fundamental concepts of symmetry and optical activity. The relationship of stereostructures to the physical and chemical properties of organic compounds. Offered in alternate years. Prerequisite: 84-523 and 84-524 or equivalent.

84-528 ELECTROANALYTICAL CHEMISTRY **I or II(3,0)3**
The intent of this course is to present an introduction to the theory and application of modern electroanalytical chemistry. The course will be divided into a discussion of elec-

trode processes, electroanalytical techniques, and the instrumentation required to make electrochemical measurements. Modern polarography, stationary electrode voltammetry, chronoamperometry, bulk electrolysis, chronopotentiometry and hydrodynamic electrochemistry will be among the topics considered. A detailed discussion of the design and operation of electrochemical detectors will be presented. Prerequisite: permission of instructor or 84-314.

84-531 STATISTICAL THERMODYNAMICS I(3,0)3
Fundamentals of equilibrium statistical mechanics, classical and quantum statistics. Molecular theories of gases, crystals, and liquids, with emphasis on chemical aspects. Electrolyte and non-electrolyte solutions, polymer and polyelectrolyte systems, chemical equilibria and reaction rate processes. Also, an introduction to nonequilibrium statistical theories. Prerequisite: 84-532 or equivalent.

84-532 ADVANCED PHYSICAL CHEMISTRY II(3,0)3
Extension of introductory physical chemistry. Open to seniors and first year graduate students in chemistry and related fields. Emphasis is placed on quantum chemistry of atoms and molecules as well as on classical and statistical thermodynamics, Prerequisite: permission of instructor.

84-534 QUANTUM CHEMISTRY I or II(3,0)3
Principles and methods of quantum mechanics with special attention to chemical applications: such as electronic structure of atoms and molecules, vibrations and rotation of molecules, and interaction of radiation and matter. Prerequisite: 84-532 or equivalent.

84-535 ADVANCED TOPICS IN PHYSICAL CHEMISTRY I(3,0)3
Selected topics and recent advances in physical chemistry. Selection of topics is at the discretion of the instructor. Prerequisite: permission of instructor.

84-536 ADVANCED TOPICS OF PHYSICAL CHEMISTRY II(3,0)3
Same as 84-535 with different topics. Prerequisite: permission of instructor.

84-538 BIOCHEMICAL MECHANISMS II(3,0)3
Discussion of various biochemical reactions from the point of view of organic reaction mechanisms. Kinetics, coenzymes and methods of study of enzyme catalysis and mechanisms will be emphasized. Prerequisites: 84-551 or permission of instructor.

84-540 CHEMICAL KINETICS II(3,0)3
The theoretical and empirical treatment of chemical kinetics data as well as the methods of obtaining these data. Determination of the order of reactions, factors influencing rates, application of rate studies in establishing hypotheses for reaction mechanisms, collision theory, and absolute rate theory. Prerequisite: 84-345 or equivalent.

84-543 MODERN INORGANIC CHEMISTRY I(3,0)3
A theoretical treatment of atomic structure and chemical bonds, included are such topics as Russell Saunders' coupling, Molecular Orbital Theory, ligand field theory, and descriptive coordination chemistry. Prerequisite: one year of physical chemistry.

84-544 CHEMICAL APPLICATION OF GROUP THEORY II(3,0)3
Classification of molecules into point groups. Properties of groups as applied to chemical systems. Development of the ligand field theory and prediction of electronic and vibration-rotational spectra. Prerequisite: 84-334, 84-534 or equivalent.

84-550 BIOCHEMISTRY I I(3-0)3
An advanced study of the structure and properties of proteins, nucleic acids, carbohydrates and lipids, including kinetics and mechanisms of enzyme action, and detailed description

of metabolic pathways of carbohydrates and lipids. Prerequisites: 84-222 or 84-224, 84-339 or 84-344, or permission of instructor.

84-551 BIOCHEMISTRY II **II(3-0)3**
A continuation of 84-550 with emphasis on metabolic pathways of amino acids and nucleic acid, biosynthesis of proteins and selected topics in molecular biology and various areas of biochemistry. Prerequisites: 84-550 or permission of instructor.

84-554 TECHNIQUES IN BIOCHEMISTRY **II(0-6)2**
Laboratory experiments designed to acquaint the student with modern techniques in biochemistry including protein purification, HPLC, NMR electrophoresis, UV-visible spectrophotometry and various types of chromatography. Prerequisites: 84-550 or permission of instructor.

84-555 SELECTED METHODS IN BIOCHEMISTRY **I(0-3)1**
A continuation of 84-554 to acquaint the student with a variety of research techniques and instrumentation in biochemistry, their theory and application. Prerequisites: 84-554 or permission of instructor.

84-563 CHEMISTRY OF NATURAL PRODUCTS **I(3,0)3**
This course will cover the proof of structure of various types of natural products, approaches to the total synthesis of these products and also the biosynthetic pathways. Prerequisites: 84-524 or 84-568 or equivalent.

84-565 HETEROCYCLIC CHEMISTRY **I(3,0)3**
Classification, nomenclature, structure, synthesis and utility of the more important classes of heterocyclic compounds. Offered in alternate years. Prerequisite: 84-524 or equivalent.

84-568 STRUCTURAL ANALYSIS **II(3,0)3**
Practical applications of instrumental data in the determination of the structure of organic compounds and polymers. Includes mass spectrometry, ultra-violet spectroscopy, infrared spectroscopy and nuclear magnetic resonance spectroscopy. Open to undergraduate and graduate students. Prerequisite: 84-222 or equivalent.

84-585 NUCLEAR CHEMISTRY **I or II(3,0)3**
This course stresses the fundamentals of radioactivity, atomic nuclei, nuclear reactions, reactors and detection and measurement of radiation. Application of material and anthropogenic radioactive tracers to oceanic and atmospheric studies are also presented. Prerequisite: permission of instructor.

Polymer Chemistry (Course Prefix: 97)

Course offerings in polymer chemistry are primarily for graduate students but are open to undergraduates with the permission of the instructor.

97-503 POLYMER SCIENCE I **I(3,0)3**
Introduction to chain statistics and thermodynamics of macromolecular solutions, methods of study of molecular weight and chain conformations, and the properties of polymers in bulk including viscoelasticity and crystallinity. Prerequisite: permission of instructor.

97-504 POLYMER SCIENCE II **II(3,0)3**
A study of the principles of condensation, free radical, ionic, coordinating and ring-opening polymerization. The topics include the concepts of step-growth and chain-growth polymerization and copolymerization. The effect of polymerization technique on reaction kinetics and molecular weight and molecular weight distribution are also discussed. Prerequisite: permission of instructor.

97-505 POLYMER PREPARATION AND CHARACTERIZATION I **I(0,4)1**
An advanced laboratory in polymer science concerned with the synthesis and characterization of macromolecules. Prerequisite: permission of instructor.

97-506 POLYMER PREPARATION AND CHARACTERIZATION II **II(0,4)1**
An advanced laboratory in polymer science concerned with the synthesis and characterization of macromolecules. Prerequisite: permission of instructor.

97-511 BIOPOLYMERS **I(3,0)3**
Topics include conformation and configuration of vinyl polymers and polypeptides, energetics of chain folding and examination of the forces dictating ordered structures, helix to coil transitions in biopolymers with emphasis on polypeptide structures, instrumental analysis of biopolymer conformation, synthesis of biopolymers including polypeptides, polysaccharides and polynucleotides, and examination of relationships between synthetic polymers and naturally occuring polymers. Prerequisite: permission of instructor.

97-512 PROPERTIES OF BULK POLYMER **II(3,0)3**
Structure and properties of bulk polymers in the glassy, rubber, and crystalline states. Topics covered include chain statistics, rubber elasticity, crystalline polymers, glass transition, segmental motion and viscoelasticity. Prerequisite: permission of instructor.

97-549 PHYSICAL CHEMISTRY OF MACROMOLECULES **I(3,0)3**
Physical Chemisty of polymers including structure and conformation, chain statistics, molecular weight distributions and averages, polymerization kinetics and classical and statistical thermodynamics of polymer systems including polyelectrolytes. Prerequisite: 97-503 or equivalent.

97-550 PHYSICAL CHEMISTRY OF MACROMOLECULES II **II(3,0)3**
Optical and hydrodynamic properties of polymer solutions. Methods of determination of structural parameters, including light scattering, viscometry, and other techniques. Prerequisite: 97-503 or equivalent.

97-553 ORGANIC CHEMISTRY OF MACROMOLECULES **I(3,0)3**
An advanced study in polymer science concerned with the synthesis of macromolecules and their mechanisms of formation. Prerequisite: 97-503, 97-504.

DEPARTMENT OF COMPUTER SCIENCE

William Moloney, Acting Chairperson

Professors: Thomas Costello, Raymond D. Gumb, David Korff, Patrick Krolack, Robert Lechner, Giampiero Pecelli, Arthur Poe

Associate Professors: Shimshon Berkovits, George Grinstein, William Moloney, Stuart Smith, Charles Steele

Assistant Professors: James Canning, Maciej Ciesielski, Nicholas Glinos, Jesse Heines, Byung Kim, David Landskov, Iheanacho Nwokogba, Charles Ryan

Instructors: John Sieg, Jeff Siegel, Peter Weston

Computer Science Major

Computer Science is the study of those problems that are best solved by means of a computer. The goal of the curriculum in Computer Science is to provide the student with the appropriate tools to identify such problems and to design and implement effective, economical, and creative solutions for them.

The required courses in the curriculum give the student a string foundation in both the software and hardware aspects of computing, and in mathematics and physics which underlie the discipline. The electives in the senior year allow the student to study deeply some particular area of computer science. The background elective requirement provides the student with a four course sequence in an area of potential in-depth application. Such diverse areas as mathematics, electrical and mechanical engineering, management, psychology, and music may be considered for the fulfillment of this requirement. Graduates in the computer science program will be prepared for employment in the computer industry or in computer applications positions and for continuation of their study in a graduate program.

Because only a limited number of entering students can be accepted into the Computer Science program, it is recommended that students present SAT scores which are at least 450 in Verbal and 550 in Mathematics. Students who have earned high grades in a laboratory course and/or foreign language in high school will be considered first for admission to the program. Beginning with the first semester of the sophomore year, and every semester thereafter, each computer science major must maintain:

a. a semester average of 2.5 or better in required major courses including computer science project courses and computer science electives.

b. a semester average of 2.3 or better in all courses.

Students who fail to satisfy these requirements will have their records reviewed by a faculty committee and, in the absence of unusual circumstances, will be dropped from the computer science program.

Summary Of Degree Requirements

1. University Core Requirements

Physical Education	2
English Composition	6
Area I (Behavioral and Social Sciences)	6-12
Area II (Fine Arts and Humanities)	6-12
Area III (Mathematics and Sciences)	9-11*
Human Values	3**

2. Major Requirements

A. Computer Science

91-101 Computer Science I	4
91-102 Computer Science II	4
91-201 Computer Science III	3
91-203 Computer Organization and Assembly Language	4
91-204 Systems Programming	4
91-301 Organization of Programming Languages	3
91-303 Advanced Data Structures	3

* The Area III requirement is met by course requirements in the computer science major.

** The human values course may simultaneously satisfy and Area I or Area II requirement if the course is found on both the Human Values list and the Area I or Area II list. Cf., "University core requirements" in the academic policies section of this bulletin. In this case a course to fill the vacancy left by combining an Area I or II with human values may be taken as a general unrestricted elective.

91-305 Computer Architecture	3
91-308 Introduction to Operating Systems	3
Computer Science Project Sequence	3-6

All computer science majors are required to take a one or two semester project course from an approved department list. Current offerings in the list include:

91-309 and 91-310 DBMS I and II	3-3
91-406 Introduction to Compiler Writing	3
91-420 and 91-421 Artificial Intelligence and Knowledge-Based Systems	3-3
91-427 and 91-428 Graphics I and II	3-3

The list is subject to continuous revision and students should check with their advisors for the latest information.

Computer Science Electives	6-9

All computer science majors are required to take two or three non-required department courses at the 91-300, 400 or graduate level. Students who take an approved one-semester project course such as compiler writing will be required to take three CS electives; otherwise, two are needed.

B. Supporting Engineering and Mathematics

92-131 or 92-133 Calculus I	4
92-132 or 92-134 Calculus II	4
95-141 Physics I and Lab	4
95-142 Physics II for computer science majors and Lab	4
92-231 or 92-233 Calculus III	4
92-321 Discrete Structures I	3
92-322 Discrete Structures II	3
92-386 Statistics for Scientists and Engineers	3
16-265 Logic Design and Lab	4

C. Additional Writing Requirement

One writing course from an approved list.	3

D. Background Elective courses 12

Each student is required to take four background electives. Background electives must be taken in the same field. The intent of this requirement is to allow students to gain an in-depth exposure to a non-computer science area. A background strategy is constructed by each individual student and his/her faculty advisor. For example:

Background in mathematics
- 92-221 Linear Algebra I
- 92-222 Linear Algebra II
- 92-234 Differential Equations
- 92-362 Numerical Analysis

3. Unrestricted General Elective Courses 6-9

These can be taken in any area. Any accredited course at a level above required courses is an acceptable general elective. Students must take two 3-credit general electives. Students who take a human values course which also satisfies an Area I or II elective must take three general electives.

4. Minimum Credit Requirement 125

COURSE OF STUDY FOR COMPUTER SCIENCE
(Bachelor Of Science)

Freshman Year

Fall Semester		Spring Semester	
91-101 Computer Science I	4	91-102 Computer Science II	4
92-131 or 92-133 Calculus I	4	92-132 or 92-134 Calculus II	4
95-141 Physics I	3	95-142 Physics II for CS	3
96-141 Physics I Lab	1	96-142 Physics II Lab	1
42-101 College Writing	3	42-102 College Writing & Lit.	3
39- Physical Education I		39- Physical Education	1
	16		16

Sophomore Year

Fall Semester		Spring Semester	
91-203 Comp. Org. & Assem. Lang.	4	91-204 Systems Programming	4
91-201 Computer Science III	3	92-322 Discrete Structures II	3
92-321 Discrete Structures I	3	92-386 Statistics for S/E	3
92-231 or 92-233 Calculus III		16-265 Logic Design/(Area I El.)	4/3
Elective (Area I)/Logic Design	3/4	Writing Elective	3
	16-17		16-17

Junior Year

Fall Semester		Spring Semester	
91-303 Adv. Data Structures	3	91-308 Intro. Operating Systems	3
91-305 Computer Architecture	3	91-301 Organization Pgm. Lang.	3
Background Elective 1	3	Background Elective 2	3
Elective (Area I)	3	Elective (Area II)	3
General Elective	3	General Elective	3
	15		15

Senior Year

Fall Semester		Spring Semester	
Project Course	3	Project Course (cont.)	3
Comp. Sci. Elective 1	3	Comp. Sci. Elective 2	3
Background Elective 3	3	Background Elective 4	3
Elective (Area II)	3	Elective (Area I or II)	3
Elective (Area I, II or HV)	3	Elective (HV or General)	3
	15		15

Computer Science (Course Prefix: 91)

91-101 COMPUTER SCIENCE I (4,0)4

Overview of computer organization. The Pascal language, data types and their representation, arithmetic and logic operations, simple I/O control structures, subprograms, arrays, records, and introduction to files. Problem solving via stepwise refinement, good programming style, documentation, and testing. All majors: required.

91-102 COMPUTER SCIENCE II (4,0)4

Recursion and dynamic data structures in Pascal. String processing. Searching and sorting methods. Hash coding. Linear storage allocation (e.g., stacks, queues) and linked allocation (e.g., linked lists, trees). Problem solving via stepwise refinement, good programming style, documentation and testing. Prerequisite: 91-101. All majors: required.

91-201 COMPUTER SCIENCE III **(3,0)3**
A continuation of Computer Science II covering advanced topics in applied data structures, including 2-3 trees, B-trees, AVL trees, general graphs, hash tables, generalized lists, multilinked structures, and files. This material will occupy approximately half to two-thirds of the semester, the remainder of the semester to be spent in implementations in languages other than Pascal (Modula-2, C, Fortran, etc.). Prerequisite: 91-102. All majors: required.

91-203 COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE PROGRAMMING **(3,1)4**
The organization and operation of a conventional computer, including principal instruction types, data representation, addressing modes, program control, and I/O. Assembly language programming, including instruction mnemonics, symbolic addresses, assembler directives, system calls and macros. The usage of one- and two-pass assemblers, text editors, symbolic debuggers, and loaders. Prerequisite: 91-101 or equivalent. All majors: required.

91-204 SYSTEMS PROGRAMMING **(3,3)4**
Issues in the functionality, design, and implementation of translation software. The focus is on assemblers, compilers, linkers, and loaders. Topics will include the objective of program translation, one-pass and two-pass assemblers, macroprocessors, program modules, block structure, external resolution, program relocation, attribute binding, and syntatic, lexical, and semantic analysis. Prerequisite: 91-201, 91-203. All majors: required.

91-301 ORGANIZATION OF PROGRAMMING LANGUAGES **(3,0)3**
This course describes the organization of programming languages, specifically the run-time behavior of programs, and introduces the formal study of programming language specifications and analysis. Examples include Ada, Apl, Common Lisp, Prolog, Smalltalk, and Snobol. Programming projects are required. Prerequisite: 91-201, 91-203, and 91-204. All majors: required.

91-303 ADVANCED DATA STRUCTURES **(3,0)3**
An advanced view of data structures and data abstractions. Emphasizes the formal properties of abstract data structures such as trees, lists, graphs, arrays, etc. The student will be expected to use the techniques learned in this course and in previous courses to solve a number of complex programming problems. Prerequisites: 91-201. All majors: required.

91-305 COMPUTER ARCHITECTURE **(3,0)3**
An examination of the principles of computer system organization. Topics include multilevel system design, high-level language and operating system support, functional unit interconnection, addressing, instruction sequencing, microprogrammed control, input/output techniques, bus organization, memory design, peripheral devices, and computer communications. Prerequisite: 91-203, 91-204, 16-265. All majors: required.

91-308 OPERATING SYSTEMS **(3,0)3**
Major operating systems and components, including processes, concurrency and synchronization, deadlock, processor allocation, memory management, I/O devices and file management, and distributed processing. Techniques in operating system design, implementation, and evaluation will be examined. Prerequisite: 91-201, 91-204, 91-305. All majors: required.

91-309 INTRODUCTION TO DATA BASE MANAGEMENT **(3,0)3**
File organization, including sequential, indexed, indexed sequential, direct access. Introduction to data base management schemes. Relational, hierarchical, and network models. Information retrieval languages. Comparison of existing data base management systems. Prerequisites: 91-201. Computer science elective or part I of project requirement.

91-310 DATA BASE MANAGEMENT II **(3,0)3**
A continuation of 91-309. Focus is on the implementation of relational data base systems. Prerequisites: 91-309, 91-303. Computer science elective or part II of project requirement.

91-406 COMPILER WRITING **(3,0)3**
Formal language concepts, including syntax and basic characteristics of grammars, Backus-Naur form, lexical analysis, top-down and bottom-up parsing. Run time storage allocation, symbol tables, hash addressing and chaining, internal forms of the source programs. Semantic routines and their implementation. Diagnostic allocation of storage to run time variables. Error recovery. Interpreters, global optimization, local code optimization. Translator writing system, translator performance, object code performance. Prerequisite: 91-204, 91-301, 91-303, 92-322. Computer science elective, or satisfies project requirement.

91-407 COMPILER WRITING PRACTICUM **(3,0)3**
A continuation of 91-406. Focus is on the implementation of a production compiler as a group project for the class. Prerequisite: 91-406. Computer science elective.

91-412 SOFTWARE ENGINEERING **(3,0)3**
The design and construction of software systems; system life-cycle; modularity, portability, adaptability, and reliability; program verification; documentation; security. Prerequisite: permission of instructor. Computer science elective.

91-413 DATA COMMUNICATIONS I **(3,0)3**
Classification of network topologies. Properties of communication channels. Line switching, message switching, and packets. Prerequisites: 91-201, 91-204, 91-305. Computer science elective.

91-414 DATA COMMUNICATIONS II **(3,0)3**
A continuation of 91-413. Prerequisite: 91-413. Computer science elective.

91-415 OFFICE AUTOMATION **(3,0)3**
Office information and decision support systems. Data and records management, electronic filing and retrieving systems, word processing, telecommunications, and local area networking. Prerequisite: 91-309. Computer science elective.

91-420 ARTIFICIAL INTELLIGENCE **(3,0)3**
LISP. Tree and graph searching algorithms: breadth first, depth first, uniform cost, heuristic search methods. Admissibility. Games: mini-max, alpha-beta. Theorem proving and question answering. Prerequisite: Permission of instructor. Computer science elective or part I of project requirement.

91-421 KNOWLEDGE BASED SYSTEMS **(3,0)3**
Other topics in artificial intelligence not covered in 91-420 such as computer vision, speech recognition, robotics, expert systems, computer art, computer music. Prerequisites: 91-420 and permission of instructor. Computer science elective or part II of project requirement.

91-425 SYMBOLIC MATHEMATICAL COMPUTATION **(3,0)3**
The use of computer algebra systems, such as MACSYMA and Reduce. Algorithms for exact computation in the integers, the ring of polynomials, finite fields, and relational functional fields. Greatest common divisor algorithm and polynomial factorization algorithms. Transcendental function arithmetic, symbolic integration algorithms. Prerequisites: 91-201, 92-322 and permission of instructor. Computer science elective.

91-427 COMPUTER GRAPHICS **(3,0)3**
Theory and technology of computer graphics; display devices and display processors; display files and transformations. Data structure considerations for computer graphics. Window-

ing, shading, perspective transformations. Graphics programming languages. Graphics system design. Vector, character, and curve generation. Prerequisites: 91-201, 92-233, 92-322. Computer science elective or part I of project requirement.

91-428 COMPUTER GRAPHICS II **(3,0)3**

A continuation of 91-427. Focus on major software production and advanced topics in graphics. Prerequisite: 91-427. Computer science elective or part II of project requirement.

91-450 ROBOTICS **(3,0)3**

The factories of the future (FOF) will require an integration of knowledge and experience from a variety of engineering and science disciplines. Further, the FOF will be strongly information driven and will involve artificial intelligence and machine vision and robotics. This design course will feature projects and laboratory work at the benchtop and prototype level in flexible manufacturing. The projects will involve using and programming robotics and the design of parts-orientation and delivery systems. Simple CAD/CAE/CIM systems will also be developed to support the operation of the FOF. Prerequisites: junior standing in engineering or computer science and FORTRAN. Computer science elective.

91-452 DIAGNOSTIC AND TEST SOFTWARE DESIGN **(3,0)3**

Virtually all major hardware products include the design and implementation of diagnostic and verification software as part of the product lifecycle. This course will examine the details of such test software and the diagnostic operating systems which support these programs. Students will design and implement diagnostic software for various hardware devices such as disk and tape subsystems. Prerequisite: 91-201, 91-204, 91-305. Computer science elective.

91-453 REAL-TIME PROGRAMMING **(3,0)3**

A survey of the programming techniques needed for applications in which a computer monitors and/or controls a process whose logical sequence is asynchronous to that of the computer. Topics covered include polling, single and multiple interrupts, real-time I/O, hardware interfaces, sampled-data systems, and feedback and control. Students will implement several microprocessor-based applications. Prerequisite: 91-203, 16-265. Computer science elective.

91-454 COMPUTER-AIDED DESIGN OF PRINTED CIRCUIT BOARDS (PBC/CAD) **(3,0)3**

This course involves specification of digital subsystem designs in machine-readable form and the use of CAD tools to produce manufacturing data. All students will participate in actual laboratory design projects leading to machine-readable manufacturing data files. Topics: economic motivation (board yield and testing problems), hierarchical organization of digital systems and schematic entry for conversion to part and net list formats. Development cycle overview, electro-mechanical constraints, wire-routing algorithms, component placement problems, manufacturing database organization and applications. Conversion of design language inputs to checkable plots and manufacturing data formats. Prerequisites: logic design (16-411 or 61-265) and knowledge of FORTRAN or Pascal programming. Computer science elective.

91-455 VLSI DESIGN **(3,3)4**

(This course is equivalent to 16-438): NMOS and CMOS technology review, lambda-based design rules and scaling concepts, logic fate performance models, the unit cell concept hierarchical partitioning and layout using gate arrays and stick diagrams, logic simulation models and their derivation from logic equations, two-dimensional layout and placement, routing and the interconnection problem. A design project to construct a digital subsystem on a VLSI chip is an integral part of this course. Prerequisites: 16-265, 91-203, 91-305. Computer science elective.

91-456 SPEECH AND RECOGNITION SYNTHESIS **(3,0)3**
This course will survey the techniques by which computer systems can generate and recognize human speech. Students will be introduced to all aspects of this interdisciplinary field (including computer science, artificial intelligence, acoustics, linguistics, psychology, physiology, physics, signal processing, etc.). Working in teams, students will implement parts of a modern speech system and explore the capabilities and limitations of present day technology. Prerequisite: permission of instructor. Computer science elective.

91-457 COMPUTER SECURITY **(3,0)3**
Basic concepts of cryptography, data security, information theory, complexity, number theory and finite field theory; encryption algorithms including the Data Encryption Standard (DES) and public key systems; incorporating cryptographic controls into computers, key management, access controls, information flow controls, and inference controls. Prerequisites; 91-309, 92-322, 92-386. Computer science elective.

91-459 SELECTED TOPICS (variable credit 1-3)
Depending on faculty interest, student demand, and developments in the field, this course may include: computability, formal languages, automata, VLSI design, computer aided design (CAD), computer aided instruction, semantics of programming languages. Prerequisite: senior status. Computer science elective.

91-480 DIRECTED STUDIES IN COMPUTER SCIENCE **(variable credit 1-3)**
Individual study for students who desire more advanced or more specialized work. This course may not be taken more than twice and may not be substituted for scheduled offerings. Prerequisite: permission of instructor. Computer science elective.

91-511 OPERATING SYSTEMS INTRODUCTION **(3,0)**
Models of operating systems, concurrency and parallelism, sychronization, multiprogramming, memory and resource management, scheduling, protection, file-structure. Prerequisite: Assembly Language and Data Structures.

91-512 SYSTEMS PROGRAMMING INTRODUCTION **(3,0)**
Assemblers, macro-processors and introduction to compilers, language design issues, structure, names, parameter passing, elements of syntactic and semantic analysis. Prerequisite: Assembly Language and Data Structures.

91-521 INTRODUCTION TO SOFTWARE ENGINEERING **(3,0)3**
Software development cycle, methods of specification, analysis and planning, introduction to testing and verification, project management. Prerequisite: Data Structures.

91-532 ORGANIZATION OF PROGRAMMING LANGUAGES **(3,0)3**
Language organization and design, definition and specification, data types and structures, control structures, procedural, functional, and applicative language, case studies of several current languages. Prerequisite: Discrete Structures and Pascal.

91-533 INTRODUCTION TO COMPILERS **(3,0)3**
An introduction to languages and compilation techniques, symbol tables, syntax analysis and parsing, semantics, code generation and optimization. Prerequisite: Pascal and Data Structures.

91-541 INTRODUCTION TO ARTIFICIAL INTELLIGENCE **(3,0)3**
Search strategies and game playing, topics in knowledge representation, reasoning, and/or perception, programming in the LISP language. Prerequisite: Assembly Language.

91-561 INTRODUCTION TO DATA COMMUNICATIONS **(3,0)3**
Elements of communication theory, models, protocols, error detection and correction,

system building blocks, management and economic issues. Prerequisite: Knoledge of Data Processing Systems.

91-562 INTRODUCTION TO NETWORKING (3,0)3
Fundamentals of distributed computer systems, taxonomy, protocols, switching, routing, and flow of control, discussion of various architectures and models, security and recovery. Prerequisite: Data Communications.

91-571 INTRODUCTION TO DATA BASE MANAGEMENT (3,0)3
Models of database systems, design of systems, issues of security, integrity, concurrency, examination of several existing systems. Prerequisite: Permission of instructor.

DEPARTMENT OF EARTH SCIENCES

Arnold L. O'Brien, Chairperson

Professors: G. Nelson Eby, Arnold L. O'Brien, Wen Tang

Associate Professors: Richard Gore

Assistant Professors: Frank P. Colby, Jr., Keith L. Seitter

Professor Emeritus: Robert C. Curtis

The Department of Earth Sciences offers major programs in environmental science and meterology, and a minor area of study in geology. The meterology major leads to the Bachelor of Science degree. The environmental science major is offered with two options; the first leads to the Bachelor of Arts degree and the second (with a geology option) leads to the Bachelor of Science degree.

Environmental Science Major

The major in environmental science is a broad-based, interdisciplinary program which is designed to provide students with an understanding of the complex inter-relationships which exist at the earth's surface. The program, which is offered with options leading to the Bachelor of Arts or Bachelor of Science degree, focuses on physical and biological systems, but also recognizes the related nature of social and economic studies. A major in environmental science will prove useful for students planning to pursue graduate work in environmental studies and in education or who wish to pursue environmentally oriented careers in business, government, and industry.

The Bachelor of Arts degree program is designed for students who wish to obtain a broad-based background in the sciences and related humanities and social sciences. A number of unrestricted elective courses permit maximum flexibility in designing a program of study which will satisfy personal goals within the context of individual competencies. Students pursuing the Bachelor of Arts degree program must complete a minimum of 45 credits and 15 courses from the offerings of the College of Liberal Arts, the College of Music, or the economics offerings of the College of Management Science.

Geology Option

For those students who are interested in geology, an option in this field is provided within the framework of the Bachelor of Science degree program in environmental science. This program provides a basic foundation for subsequent studies in such subfields of applied geology as mineral exploration and exploitation, engineering geology, geologic hazard evaluation, and energy resource development. For the student possessing the necessary science competencies, a wide range of career opportunities is available. Geologists are employed by energy and mineral resource companies, federal and state geological surveys, the Environmental Protection Agency, and environmental consulting firms. Students planning to pursue such career opportunities should recognize that training at the graduate level is required in most cases.

For those students interested in teaching, the College of Education offers a graduate degree program designed to prepare elementary teachers and secondary teachers in Earth Science. This year long program (September to June) provides the course work and the apprentice teaching experience required for certification in Massachusetts and in thirty-three other states. See graduate catalogue for requirements for admission. Interested persons may obtain additional information from Dr. Gail Carney, Director of Field Experiences, College of Education.

Summary Of Degree Requirements (Bachelor of Arts)

1. University Core Requirements	**26**
Physical Education	2
English Composition	6
Area I (Behavioral & Social Sciences)	6-12*
Area II (Fine Arts & Humanities)	6-12*
Area III (Mathematics & Sciences)	(9-11)*
Human Values Requirement	(3)+
2. Major Field Requirements**	**77-84**
A. Environmental Sciences	**25**
87-101 Introduction to Environmental Sciences	1
87-102 Foundations of Conservation	3
93-211 Atmospheric Science	3
93-213 Atmospheric Science Laboratory	1
87-401 Seminar in Remote Sensing of the Environment	3
89-203 Oceanography	3
89-205 Oceanography Laboratory	1
89-213 Environmental Geology	3
89-314 Hydrogeology	3
81-315 Principles of Ecology	2
81-317 Principles of Ecology Laboratory	2

* A minimum of two courses and six semester credits must be presented from approved courses in each of Area I and Area II, plus two additional courses and six semester credits selected from either or both of these areas. Area III requirements are met by the required courses of the Major Field Requirements. Students are restricted to a maximum of two courses from any one department, and are limited to two literature courses, irrespective of department listing.

+ The Human Values requirement is met within the framework of the major courses.

** Prerequisites for courses in the major field, or courses which are prerequisites for admission to the College of Pure and Applied Sciences, may not be credited to requirements for degrees in the College of Pure and Applied Sciences.

B. Area of Focus **14-16**

Environmental science majors must elect a minimum of four courses (14 or more semester credits) from one of the following three categories:

1. Biological Aspects of Environmental Science

81-201 General Microbiology	3
81-203 General Microbiology Laboratory	1
81-215 Introduction to Marine Biology	2
81-217 Introduction to Marine Biology Laboratory	1
81-224 Introduction to Insect Biology	2
81-226 Introduction to Insect Biology Laboratory	1
81-228 Ornithology	2
81-230 Ornithology Laboratory	1
81-331 Quantitative Ecology	3
81-333 Quantitative Ecology Laboratory	1
81-335 Genetics	3
81-337 Genetics Laboratory	1
81-422 Plant Physiology	3
81-424 Plant Physiology Laboratory	1
81-510 Limnology	3
81-512 Limnology Laboratory	1
82-354 Wildlife and Environmental Management	3

2. Geological Aspects of Environmental Science

89-208 Paleontology	3
89-210 Paleontology Laboratory	1
89-251 Mineralogy	3
89-253 Mineralogy Laboratory	1
89-301 Optical Mineralogy	3
89-303 Optical Mineralogy Laboratory	1
89-304 Igneous and Metamorphic Petrology	3
89-306 Igneous and Metamorphic Petrology Laboratory	1
89-316 Geomorphology	3
89-318 Geomorphology Laboratory	1
89-322 Structural Geology	3
89-324 Structural Geology Laboratory	1
89-352 Stratigraphy and Sedimentation	3
89-354 Stratigraphy and Sedimentation Laboratory	1
89-452 Geochemistry	3

3. Chemical Aspects of Environmental Science

84-207 Inorganic Chemistry	3
84-209 Inorganic Chemistry Laboratory	2
84-221 Organic Chemistry IA	3
83-222 Organic Chemistry IIA	3
84-227 Organic Chemistry Laboratory I	1
84-228 Organic Chemistry Laboratory II	1
84-324 Principles of Analytical Chemistry	3
84-325 Principles of Analytical Chemistry Laboratory	1
84-344 Physical Chemistry I	3

84-346 Physical Chemistry Laboratory I	1
84-342 Organic Qualitative Analysis	3
84-484 Radiochemistry	3

C. Supporting Sciences and Mathematics	**38-43**
1. 92-131 Calculus I and two additional mathematics course	10-12
2. 81-111,113 Principles of Biology I with Laboratory 81-112,114 Principles of Biology II with Laboratory	8
3. 84-121,123 Chemistry I with Laboratory 84-122,124 Chemistry II with Laboratory	8
4. Two semesters of introductory physics	8-11
5. 89-121, 123 Physical Geology with Laboratory	4

3. Elective Courses

Students pursuing the Bachelor of Arts Degree are required, at a minimum, to take 27 credits from the offerings of the College of Liberal Arts, the College of Music, or the economics offerings of the College of Management Science. These courses are selected by students in accordance with their needs, talents, and interests in consultation with their faculty advisors.

4. Minimum Credit Requirement 129

SAMPLE COURSE OF STUDY FOR ENVIRONMENTAL SCIENCES (Bachelor of Arts)

Freshman Year

Fall Semester	
42-101 College Writing I	3
84-121 Chemistry I	3
84-123 Chemistry I Laboratory	1
92-131 Calculus I	4
89-121 Physical Geology	3
89-123 Phys. Geol. Lab.	1
87-101 Intro. to Environ. Science	1
	17

Spring Semester	
42-102 College Writing II	3
84-122 Chemistry II	3
84-124 Chemistry II Laboratory	1
87-102 Foundations of Conservation	3
92- Mathematics Elective	3-4
39- Physical Education	1
39- Physical Education	1
	14-15

Sophomore Year

Fall Semester	
81-111 Prin. of Biology I	3
81-113 Prin. of Biology Lab.	1
95-201 Prin. of Physics I	3
96-201 Prin. of Physics I Lab.	1
89-213 Environmental Geology	3
92- Mathematics Elective	3-4
Elective (Area I or II)	3
	17-18

Spring Semester	
81-112 Prin. of Biology II	3
81-114 Prin. of Biology II Lab	1
95-202 Prin. of Physics II	3
96-202 Prin. of Physics II Lab	1
89-314 Hydrogeology	3
Elective (Area I or II)	3
Elective (Liberal Arts)	3
	17

Junior Year

Fall Semester		Spring Semester	
93-211 Atmospheric Science	3	89-203 Oceanography	3
93-213 Atmospheric Science Lab.	1	89-205 Oceanography Lab.	1
81-315 Principles of Ecology	3	Elective (Focus)	4
81-317 Principles of Ecology Lab.	1	Elective (Area I or II)	3
Elective (Focus)	4	Elective (Liberal Arts)	6
Elective (Area I or II)	3		
	15		17

Senior Year

Fall Semester		Spring Semester	
87-401 Environ. Science Seminar	3	Elective (Focus)	3-4
Elective (Focus)	3-4	Electives (Liberal Arts)	12
Electives (Liberal Arts)	9		
	15-16		15-16

Summary Of Degree Requirements: Geology Option (Bachelor of Science)

1. University Core Requirements 26

Physical Education	2
English Composition	6
Area I (Behavioral & Social Sciences)	6-12*
Area II (Fine Arts & Humanities)	6-12*
Area III (Mathematics & Sciences)	(9-11)*
Human Values Requirement	(3)+

2. Major Field Requirements** 92-96

A. Environmental Sciences	22
87-101 Introduction to Environmental Sciences	1
87-102 Foundations of Conservation	3
93-211 Atmospheric Science	3
93-213 Atmospheric Science Laboratory	1
87-401 Seminar in Remote Sensing of the Environment or 89-495 Honors Research in Geology	3
89-203 Oceanography	3
89-205 Oceanography Laboratory	1
89-314 Hydrogeology	3
81-315 Principles of Ecology	2
81-317 Principles of Ecology Laboratory	2

* A minimum of two courses and six semester credits must be presented from approved courses in each of Area I and Area II, plus two additional courses and six semester credits selected from either or both of these areas. Area III requirements are met by the required courses of the major field requirements. Students are restricted to a maximum of two courses from any one department, and are limited to two literature courses, irrespective of department listing.

+ The Human Values requirement is met within the framework of the Major courses.

** Minor areas of study require a minimum of 18-24 credits with at least 6 credits at the 300-400 level.

B. Geology Option	**31**
89-208 Paleontology	3
89-210 Paleontology Laboratory	1
89-251 Mineralogy	3
89-253 Mineralogy Laboratory	1
89-301 Optical Mineralogy	3
89-303 Optical Mineralogy Laboratory	1
89-304 Igneous and Metamorphic Petrology	3
89-306 Igneous and Metamorphic Petrology	1
89-316 Geomorphology	3
89-318 Gemorophology Laboratory	1
89-322 Structural Geology	3
89-324 Structural Geology Laboratory	1
89-352 Stratigraphy & Sedimentation	3
89-354 Stratigraphy & Sedimentation Laboratory	1
Geology Elective	3
89-326 Glacial and Pleistocene Geology or	
89-431 Regional Geology or	
89-452 Geochemistry or	
89-454 Economic Geology	

C. Supporting Sciences and Mathematics	**39-43**
1. 92-131 Calculus I	4
92-132 Calculus II, and one additional mathematics course	7-8
2. 81-111,113 Principles of Biology I with Laboratory	4
81-112,114 Principles of Biology II with Laboratory	4
3. 84-121,123 Chemistry I with Laboratory	4
84-122,124 Chemistry II with Laboratory	4
4. 95-201,202 and 96-201, 202 Principles of Physics with Laboratory	8
or	
95-141,144, 245 and 96-141, 144, 245: Physics with Laboratory	11
5. 89-121,123 Physical Geology with Laboratory	4

3. Unrestricted Elective Courses 3-12

4. Minimum Credit Requirement 122

SAMPLE COURSE OF STUDY FOR ENVIRONMENTAL SCIENCE: GEOLOGY OPTION (Bachelor Of Science)

Freshman Year

Fall Semester		Spring Semester	
42-101 College Writing I	3	42-102 College Writing II	3
84-121 Chemistry I	3	84-122 Chemistry II	3
84-123 Chemistry I Laboratory	1	84-124 Chemistry II Laboratory	1
92-131 Calculus I	4	87-102 Foundations of Conservation	3
89-121 Physical Geology	3	92-132 Calculus II	4
89-123 Physical Geology Laboratory	1	Elective (Area I or II)	3
87-101 Intro. to Environ. Science	1	39- Physical Education	1
39- Physical Education	1		
	17		18

Sophomore Year

Fall Semester		Spring Semester	
81-111 Principles of Biology I	3	81-112 Principles of Biology II	3
81-113 Principles of Biology I Lab.	1	81-114 Principles of Biology II Lab.	1
95-201 Principles of Physics I	3	95-202 Principles of Physics II	3
96-201 Principles of Physics I Lab.	1	96-202 Principles of Physics II Lab.	1
89-322 Structural Geology	3	89-315 Hydrogeology	3
89-324 Structural Geology Lab.	1	89-316 Geomorphology	3
92- Mathematics Elective	3-4	89-318 Geomorphology Laboratory	1
	15-16		15

Junior Year

Fall Semester		Spring Semester	
93-211 Atmospheric Science	3	89-203 Oceanography	3
93-213 Atmospheric Science Lab.	1	89-205 Oceanography Laboratory	1
81-315 Principles of Ecology	3	89-301 Optical Mineralogy	3
81-317 Principles of Ecology Lab.	1	89-303 Optical Mineralogy Lab.	1
89-251 Mineralogy	3	89-352 Sedimentation & Stratigraphy	3
89-253 Mineralogy Laboratory	1	89-354 Sedimen. & Stratigraphy Lab.	1
89-208 Paleontology	3	Elective (Area I or II)	3
89-210 Paleontology Laboratory	1		
	16		15

Senior Year

Fall Semester		Spring Semester	
87-407 Environ. Science Seminar	3	Geology Elective	3
89-304 Petrology	3	Elective (Area I or II)	3
89-306 Petrology Laboratory	1	Electives	9
Electives (Area I or II)	6		
Elective	3		
	16		15

Geology Minor

A minor in geology consists of 89-121: Physical Geology and five courses from the following listings, two of which must be at the 300 course level or above.

89-208 Paleontology
89-251 Mineralogy
89-301 Optical Mineralogy
89-304 Igneous and Metamorphic Petrology
89-314 Hydrogeology
89-316 Geomorphology
89-322 Structural Geology
89-352 Sedimentation and Stratigraphy

Meteorology Major

The meteorology major is offered under the requirements of the College of Pure and Applied Sciences for the Bachelor of Science degree. The goal of the meteorology program is to provide students with a knowledge of the fundamental principles and techniques of physics and mathematics which is necessary for understanding atmospheric behavior and for solving practical problems concerning weather and climate. Because meteorology is primarily the application of the principles and techniques of physical sciences to the study of the atmosphere, the meterology curriculum specifies a substantial core of supporting science and mathematics courses.

The work of the meteorologist is concentrated on the effort to understand the physical causes of weather and climate and to apply this knowledge to the solution of practical problems ranging from the forecasting of weather to the analysis of the influence of weather and climate on public health, agriculture, engineering, industry and commerce, and national defense. Meteorologists are employed by the agencies of the federal government, the National Oceanic and Atmospheric Administration, the National Weather Service, and the Department of Defense, as well as by agencies of state and local governments, and by commercial aviation companies and private consulting firms. Meteorology students who wish to continue their studies at the graduate level are advised to develop competencies in science and mathematics, especially in computer science, beyond those which are mandated by the supporting science and mathematics core.

Summary of Degree Requirements

1. University Core Requirements 26

Physical Education	2
English Composition	6
Area I (Behavioral & Social Sciences)	6-12*
Area II (Fine Arts & Humanities)	6-12*
Area III (Mathematics & Sciences)	(9-11)*
Human Values Requirement	(3)

2. Major Field Requirements** 91

A. Meteorology 40

93-101 Seminar in Meteorology	1
93-102 Weather Forecasting Seminar	1
93-211 Atmospheric Science	3
93-213 Atmospheric Science Laboratory	1
93-212 Meteorological Analysis	3
93-214 Meteorological Analysis Laboratory	1
93-301 Atmospheric Dynamics I	3
93-302 Atmospheric Dynamics II	3
93-304 Methods in Meteorology I	3
93-305 Methods in Meteorology II	3
93-308 Forecasting and Synoptic Techniques I	3
93-309 Forecasting in Synoptic Techniques II	3
93-403 Physical Meteorology	3
93-415 Advanced Atmospheric Dynamics I	3
93-416 Advanced Atmospheric Dynamics II	3
93-430 Atmospheric Diffusion	3

* A minimum of two courses and six semester credits must be presented from approved courses in each of Area I and Area II, plus two additional courses and six semester credits selected from either or both of these areas. Area III requirements are met by the required courses of the Major Field Requirements. Students are restricted to a maximum of two courses from any one department, and are limited to two literature courses, irrespective of department listing.

** Prerequisites for courses in the major field, or courses which are prerequisites for admission to the College of Pure and Applied Sciences, may not be credited to requirements for degrees in the College of Pure and Applied Sciences.

B. Science/Meteorology Electives **9**

A minimum of 3 electives are to be chosen from the following list. Substitutions may be made with the approval of the department chairman.

93-313	Physical Climatology	3
93-340	Tropical Meteorology	3
93-350	Satellite and Radar Meteorology	3
93-360	Meteorology of the Upper Atmosphere	3
93-410	Advanced Forecasting	3

C. Chemistry **8**

84-121	Chemistry I	3
84-123	Chemistry I Laboratory	1
84-122	Chemistry II	3
84-124	Chemistry II Laboratory	1

D. Mathematics **21**

92-131	Calculus I	4
92-132	Calculus II	4
92-231	Calculus III	4
92-234	Differential Equations	3
92-263	Fortran Programming	3
92-386	Statistics for Science and Engineering	3

E. Physics **12**

95-141	Physics I	3
96-141	Fundamentals of Experimental Physics I	1
95-144	Physics II	3
96-144	Fundamentals of Experimental Physics II	1
95-245	Physics III	3
96-245	Fundamentals of Experimental Physics II	1

3. Unrestricted Elective Courses 6

4. Minimum Credit Requirement 122

SAMPLE COURSE OF STUDY FOR METEOROLOGY (Bachelor of Science)

Freshman Year

Fall Semester		Spring Semester	
84-121 Chemistry I	3	84-122 Chemistry II	3
84-123 Chemistry I Laboratory	1	84-124 Chemistry II Laboratory	1
92-131 Calculus I	4	92-132 Calculus II	4
93-101 Seminar in Meteorology	1	93-102 Weather Forcasting Seminar	1
95-141 Physics I	3	95-144 Physics II	3
96-141 Fund. of Exper. Physics I	1	96-144 Fund. of Exper. Physics II	1
42-101 College Writing I	3	42-102 College Writing II	3
39- Physical Education	1	39- Physical Education	1
	17		17

Sophomore Year

Fall Semester		
92-231	Calculus III	4
92-263	Fortran Programming	3
93-211	Atmospheric Science	3
93-213	Atmospheric Science Lab.	1
95-245	Physics III	3
96-245	Fund.of Exper. Physics III	1
		15

Spring Semester		
92-234	Differential Equations	3
92-386	Statistics for Science & Engineering	3
93-212	Meteorological Analysis	3
93-214	Meteorological Analysis Lab.	1
	Electives (Area I or II)	6
		16

Junior Year

Fall Semester		
93-304	Methods in Meteorology I	3
93-301	Atmospheric Dynamics I	3
93-308	Forecasting and Synoptic Techniques I	3
	Science/Meteorology Elective	3
	Elective (Area I or II)	3
		15

Spring Semester		
93-305	Methods in Meteorology II	3
93-302	Atmospheric Dynamics II	3
93-309	Forecasting and Synoptic Techniques II	3
	Science/Meteorology Elective	3
	Elective (Area I or II)	3
		15

Senior Year

Fall Semester		
93-403	Physical Meteorology	3
93-415	Advanced Atmos. Dynamics I	3
	Science/Meteorology Elective	3
	Elective (Unrestricted**)	3
	Elective (Area I or II)	3
		15

Spring Semester		
93-430	Atmospheric Diffusion	3
93-416	Advanced Atmos. Dynamics II	3
	Science/Meteorology Elective*	3
	Elective (Unrestricted**)	3
	Elective (Area I or II)	3
		15

* Only three of the science/meteorology electives are necessary to satisfy the major requirements.

** R.O.T.C. students may use two 3-credit Aerospace science courses as their electives.

Environmental Sciences (Course Prefix: 87)

87-101 INTRODUCTION TO ENVIRONMENTAL SCIENCE I(2,0)1

A survey of the field of environmental science. Topics considered include air, water, and noise pollution; solid and liquid waste disposal; and social, political, and economic implications of these problems. Readings, discussions, guest speakers, and field trips will be utilized. Only for environmental science majors.

87-102 FOUNDATIONS OF CONSERVATION AND ENVIRONMENTAL CONCERN I,II(3,0)3

A study of the evolution of American environmental perception. Topics include a historical review of the changes in federal land policy, and the contributions of naturalists, scientists and laymen toward establishing a concern for environmental quality.

87-103 THE EARTH AND ITS ENVIRONMENT I I(3,0)3

An investigation of the interaction between science and man's understanding and use of the earth and its environment. Origin of the universe and solar system, the dynamic earth, earth resources, astronomical and geologic time.

87-104 THE EARTH AND ITS ENVIRONMENT II II(3,0)3

An investigation of the interaction between science and man's understanding and use of the earth and its environment. Ecology, population and the earth, land and water surface of the earth, the atmosphere.

87-105 THE EARTH AND ITS ENVIRONMENT LABORATORY I **I(0,2)1**
Application of physical principles to the study of the earth and its environment. Interstellar distances, geomagnetism, earthquakes, minerals, age determinations.

87-106 THE EARTH AND ITS ENVIRONMENT LABORATORY II **II(0,2)1**
Application of physical principles to the study of the earth and its environment. Landforms, hydrologic cycle, weather, climate, cycle of pollutants.

87-115 ASTRONOMY **I,(3,0)3**
An introduction to the study of astronomy including historical development, instruments, solar system dynamics, planetary evolution, stellar systems and stellar evolution.

87-117 ASTRONOMY LABORATORY **I,(0,2)1**
The laboratory is intended to develop a deeper understanding of astronomy through an exposure to the methods and materials used in astronomical analysis. Corequisite 87-115.

87-401 SEMINAR IN REMOTE SENSING OF THE ENVIRONMENT **I,(3,0)3**
Selected topics in environmental science will be explored in depth through applications of high altitude aerial and satellite imagery. Analysis of the appropriate uses of various active and passive sensor systems will be followed by a project in which the student will utilize remotely sensed data to delineate the significance of environmental problems. Prerequisite: senior standing in environmental science.

87-491 DIRECTED STUDY IN ENVIRONMENTAL SCIENCE **I,II(ARR)1-3**
The student, through regular and frequent consultation with the instructor, will undertake independent study of a particular area of environmental science. Prerequisite: permission of instructor.

87-496 PRACTICUM EXPERIENCE **I,II(ARR)1-3**
A program of campus and/or off-campus experiences developed by the student in consultation with an earth science's faculty member and, when appropriate, a member of the staff of an off-campus firm. May be repeated to a maximum of 6 credits. The practicum may not be substituted for a required course in the major. Prerequisite: permission of department chairperson.

Geography (Course Prefix: 88)

88-101 WORLD AND REGIONAL GEOGRAPHY **I(3,0)3**
A survey of the significance, characteristics, and principal geographic problems of the world's major regions.

88-126 GEOGRAPHY OF THE UNITED STATES AND CANADA **II(3,0)3**
A regional geography of North America, with emphasis on the human and physical characteristics of different geographic regions and their interaction with each other.

Geology (Course Prefix: 89)

89-101 GENERAL GEOLOGY I **I(3,0)3**
A study of the earth with emphasis on earth materials, earth structure (crustal and internal), earth history, and the development of life. Designed for the general student.

89-102 GENERAL GEOLOGY II **II(3,0)3**
A study of the earth with emphasis on the surface of the earth and landform development. Includes special topics introducing the student to recent geological research and applied geological knowledge. Designed for the general student.

89-103 GENERAL GEOLOGY LAB I **I(0,2)1**
Corequisite: 89-101

89-104 GENERAL GEOLOGY LAB II **II(0,2)1**
Corequisite: 89-102

89-121 PHYSICAL GEOLOGY **I(3,0)3**
An introduction to the physical processes by which the earth undergoes change. Topics include tectonism, petrogenesis, and degradation through various surficial agents. This course should be of primary interest to the science student. Corequisite: 89-123.

89-123 PHYSICAL GEOLOGY LABORATORY **I(0,3)1**
Corequisite: 89-121.

89-203 OCEANOGRAPHY **II(3,0)3**
A survey of the geologic, chemical, physical, and biological aspects of the oceans. Topics include a study of the topography, structure, and origin of ocean basins and their margins; marine sedimentation; chemistry and circulation of ocean water; and biological environments. Prerequisite: one year each of college physics and chemistry. Corequisite: 89-205.

89-205 OCEANOGRAPHY LABORATORY **II(0,3)1**
Corequisite: 89-203

89-208 PALEONTOLOGY **I(3,0)3**
A study of the nature and origin of fossils including their biology, morphology, paleoecology, taxonomy, and evolutionary history. Special emphasis on the role of fossils in geologic chronology and correlation. Prerequisite: 89-121.

89-210 PALEONTOLOGY LABORATORY **I(0,2)1**
Corequisite: 89-208

89-213 ENVIRONMENTAL GEOLOGY **I(3,0)3**
A study of how the abundance, occurrence and distribution of natural resources, and general geologic conditions, limit the activities of man. Topics include: the energy gap, natural resource limits on food production and industrial expansion, pollution accompanying resource utilization, urban geology and geologic hazards in land development.

89-251 MINERALOGY **I(3,0)3**
An introduction to mineral identification and mineral structure with emphasis on laboratory determination. The course will examine the physical, chemical, and crystallographic properties of minerals. Prerequisite: one semester of chemistry. Corequisite: 89-253.

89-253 MINERALOGY LABORATORY **I(0,2)1**
Corequiste: 89-251

89-301 OPTICAL MINERALOGY **II(3,0)3**
A systematic treatent of the optical properties of minerals. Use is made of crystallographic theory and optical-indicatrix representations to identify minerals with the polarizing microscope and X-ray diffractometer. Laboratory emphasizes oil immersion techniques and thin section identificaion with an introduction to spindle stage methods. Prerequisite: 89-251. Corequisite: 89-303.

89-303 OPTICAL MINERALOGY LABORATORY **II(0,2)1**
Corequisite: 89-301.

89-304 IGNEOUS AND METAMORPHIC PETROLOGY **I(3,0)3**
A study of the composition, classification, and origin of igneous and metamorphic rocks. Emphasis will be on thin section identification and use of rock textures and compositions as guides to petrogenesis. Prerequisite: 89-301.

89-306 IGNEOUS AND METAMORPHIC PETROLOGY LABORATORY I(0,3)1
Corequisite: 89-304.

89-314 HYDROGEOLOGY II(3,0)3
A study of the distribution and movement of water on the earth's surface with emphasis on the geologic effects. Topics include: application of statistics to streams, ground-water flow nets, well hydraulics. Prerequisite: 92-131.

89-316 GEOMORPHOLOGY II(3,0)3
A study of the physical and chemical processes at work on the earth's surface which result in the formation and development of surface features. Emphasis is placed on the mechanics of erosion (water, wind, ice, and waves) and the morphology and spatial distribution of the resultant landforms. Prerequisite: 89-121. Corequisite: 89-318.

89-318 GEOMORPHOLOGY LABORATORY II(0,2)1
Corequisite: 89-316

89-322 STRUCTURAL GEOLOGY I(3,0)3
An analysis of crustal deformation through detailed study of geologic structures with emphasis upon the response of geologic materials to stress. Field techniques, tectonic principles, and three-dimensional graphic analysis are employed. Prerequisite: one semester of physics: Corequisite: 89-324.

89-324 STRUCTURAL GEOLOGY LABORATORY I(0,2)1
Corequisite: 89-322.

89-326 GLACIAL AND PLEISTOCENE GEOLOGY II(3,0)3
A survey and interpretation of the erosional and depositional effects of glaciation with emphasis on the New England area. Topics include glaciology, glacial geology, and Pleistocene stratigraphy. Prerequisite: 89-316.

89-352 SEDIMENTATION AND STRATIGRAPHY II(3,0)3
A study of the principles and processes of sedimentation and the resulting stratigraphic and structural units. Laboratory work includes stratigraphic cross-sections, identification and description of sedimentary rocks, and structures and determination of mass properties of sediments with emphasis on mechanical and statistical analysis. Prerequisite: 89-121. Corequisite: 89-354.

89-354 SEDIMENTATION AND STRATIGRAPHY LABORATORY II(0,2)1
Corequisite: 89-352.

89-431 REGIONAL GEOLOGY II(3,0)3
A survey of the stratigraphy, geologic structure, and physiography of various areas of the world with emphasis on North America. Discussions on the origin of various geologic provinces and the development of a model for global tectonics. Prerequisites: 89-322, 89-208, 89-352.

89-452 GEOCHEMISTRY II(3,0)3
Application of chemical principles to geologic problems. Topics include crystal chemistry, phase equilibria, stable isotopes and age dating, oxidation-reduction and pH of natural environments, abundance and distribution of elements in the earth, origin and evolution of igneous, metamorphic, and sedimentary rocks. Prerequisite: one year of college chemistry.

89-454 ECONOMIC GEOLOGY II(3,0)3
A study of the processes which lead to the formation of nonmetallic and metallic mineral deposits. Topics will include the origin of fossil fuels, sedimentary ore deposits, and ore deposits formed by igneous and metamorphic processes. Prerequisite: 89-304, 89-352.

89-491 DIRECTED STUDY IN GEOLOGY **I,II(ARR)1-3**
The student, through regular and frequent consultation with the instructor, will undertake independent study of a particular area of geology. Prerequisite: permission of instructor.

89-495 HONORS RESEARCH IN GEOLOGY **I,II(ARR)3-6**
An independent scientific research project carried out by a qualified senior under the supervision of a faculty member. May be taken by B.S. majors in lieu of 87-401. Prerequisite: consent of supervising faculty member.

Meteorology (Course Prefix: 93)

93-101 SEMINAR IN METEOROLOGY **I(0,I)1**
An introduction to the field of meteorology covering historical background, introduction to the weather map, applications, and areas of current research. Restricted to students majoring in meteorology.

93-102 WEATHER FORECASTING SEMINAR **II(0,2)1**
Introduction to forecasting techniques including use of upper air observations and numerical forecast guidance. Prerequisite: 93-101.

93-141 WEATHER AND CLIMATE **I,II(3,0)3**
A general meteorology course for the nonscience major. Topics include: atmospheric composition, solar radiation, temperature, moisture and condensation, relationship between air pressure and wind, weather patterns, severe weather, optical phenomena in the atmosphere, and the behavior and possible change of climate.

93-211 ATMOSPHERIC SCIENCE **I(3,0)3**
An introduction to atmospheric science, including such topics as: the origin, thermal structure and composition of the atmosphere, atmospheric and solar radiation, atmospheric heat budget, elements of atmospheric thermodynamics and hydrodynamics, equation of state, first law of thermodynamics, hypsometric equation, geostrophic and gradient motion, thermal wind, cyclones, anticyclones, fronts, waves, jet streams, global circulation, climate, elements of climatic change, pollution and its effect on weather and climate. Prerequisite: 92-131 and 95-144. Corequisite: 93-213.

93-212 METEOROLOGICAL ANALYSIS **II(3,0)3**
An introductory course in meteorological analysis, covering such topics as: observational meteorology, fog, clouds, optical phenomena, precipitation, thunderstorms and tornadoes, elements of weather map plotting and analysis, decoding upper air reports, thermodynamic diagram plotting and interpretation. Prerequisite: 93-211. Corequisite: 93-214.

93-213 ATMOSPHERIC SCIENCE LABORATORY **I(0,2)1**
Corequisite: 93-211.

93-214 METEOROLOGICAL ANALYSIS LABORATORY **II(0,2)1**
Corequisite: 93-212.

93-301 ATMOSPHERIC DYNAMICS I **I(3,0)3**
A study of the thermodynamics of dry air, water vapor and moist air, hydrostatic equilibrium and its stability, and the dynamics of convection. Prerequisite: 93-211.

93-302 ATMOSPHERIC DYNAMICS II **II(3,0)3**
A course in dynamics which covers: the equations governing large-scale frictionless motion in the atmosphere, steady state motion, development of thermal circulations, barotropic and baroclinic conditions, circulation, vorticity and divergence, solenoids, and mechanism of pressure change. Prerequisite: 93-301.

93-304 METHODS IN METEOROLOGY I **I(3,0)3**
The application of vector analysis to dynamic meteorology. Topics include: three dimensional divergence and vorticity, circulation and solenoids, selected ordinary and partial differential equation of fluid mechanics and their solutions, and spectral decomposition of hemispheric wave motion. Prerequisite: 93-212.

93-305 METHODS IN METEOROLOGY II **II(3,0)3**
A study of the fundamentals of numerical weather prediction. Topics covered are: data analysis methods in meteorology using the techniques of curve fitting, correlation, power spectrum analysis, and solution of stability problems. Prerequisites: 92-263 and 93-304.

93-308 FORECASTING AND SYNOPTIC TECHNIQUES I **I(1,4)3**
This course covers the techniques of synoptic analysis including: graphical subtraction, thickness analysis, isentropic analysis, streamlines and trajectories, divergence and vorticity. The use of a computer to perform these computations will be explored through student projects. Prerequisite: 93-212.

93-309 FORECASTING AND SYNOPTIC TECHNIQUES II **II(1,4)3**
Synoptic analysis and forecasting techniques are covered including: three-dimensional structure and dynamics of mid-laditude storm systems, capabilities and limitations of the barotropic model, quasi-geostrophic model, and operational primitive equation models. Some mesoscale phenomena will be covered as time permits including coastal cyclogenesis, thermal lows, sea-breeze circulations, and frontal circulations. Prerequisite: 93-308.

93-313 PHYSICAL CLIMATOLOGY **I(3,0)3**
A concentration on the atmospheric processes determining climate, including: solar and terrestrial radiation, elevation and thermal properties of surfaces, atmospheric circulations and eddy conduction between the atmosphere and land or sea surfaces, heat and water balance of earth's surface and the atmosphere, hydrological cycle, and climatic simulation models. Prerequisite: 93-212 or permission of instructor.

93-340 TROPICAL METEOROLOGY **I(3,0)3**
An introduction to the tropical atmosphere including tropical climatology, structure and dynamics of easterly waves, tropical cyclones and monsoonal circulations. Prerequisite: 93-212.

93-350 SATELLITE AND RADAR METEOROLOGY **II(3,0)3**
A survey of the theory and applications of radar, satellites, and lidar including: use of satellite imagery as a forecasting aide, theory and use of satellite profiling, application of conventional and Doppler radar to severe weather and short term forecasting, and the use of lidar and other profiling techniques to determine vertical temperature structure and turbulence. Prerequisite: 93-212.

93-360 METEOROLOGY OF THE UPPER ATMOSPHERE **II(3,0)3**
A study of the upper atmosphere including topics such as: structure of the stratosphere, mesosphere, and thermosphere, chemistry and photochemistry of upper atmosphere, formation and maintenance of ozone layer, UVB absorption, general circulation of the stratosphere, quasi-biennial oscillation, sudden stratospheric warming, ionospheric structure, magnetosphere, aurora borealis. Prerequisite: 93-212.

93-403 PHYSICAL METEOROLOGY **I(3,0)3**
A study of solar and terrestrial radiation processes, the heat balance of the atmosphere, fundamentals of radiation theory, radiative transfer processes in the atmosphere, atmospheric condensation processes, nucleation theory and the growth of water drops and ice crystals by condensation, sublimation and accretion. Prerequisite: 93-301.

93-410 ADVANCED FORECASTING **II(1,4)3**
Advanced analysis techniques and their use as forecasting tools will be explored in both manual and computer formats. Techniques will include moisture advection; moist isentropic trajectories, boundary layer destabilization, and application of techniques to small and mesoscale phenomena. Prerequisite: 93-308.

93-415 ADVANCED ATMOSPHERIC DYNAMICS I **I(3,0)3**
A study of advanced topics in dynamics such as: dynamics of rotating fluids, potential vorticity equation, atmospheric discontinuities, perturbation theory of wave motions, sutcliffe development, and elements of numerical weather prediction. Prerequisite: 93-301.

93-416 ADVANCED ATMOSPHERIC DYNAMICS II **II(3,0)3**
Further study in advanced dynamics including: stability of atmospheric circulations, barotropic and baroclinic models, atmospheric energy transformations, and general circulation theory. Prerequisite: 93-415.

93-430 ATMOSPHERIC DIFFUSION **II(3,0)3**
A study of micrometeorology and the meteorological processes that affect the diffusion and removal of atmospheric pollutants. Topics include: theories of diffusion and their application to the calculation of concentrations, the effects of obstacles and topography on atmospheric diffusion and transport, and meteorological factors involved in the design and location of stacks. Prerequisite: 93-302.

93-491 DIRECTED STUDY IN METEOROLOGY **I,II(ARR)1-3**
The student, through regular and frequent consultation with the instructor, will undertake independent study of a particular area of meteorology. Prerequisite: permission of instructor.

93-495 RESEARCH PROJECT **I,II(ARR)3-6**
An individual or team research project carried out by qualified students with the approval of, and supervision by, a faculty member. Prerequisite: consent of supervising faculty member.

93-496 PRACTICUM EXPERIENCE **I,II(ARR)1-3**
A program of campus and/or off-campus experiences developed by the student in consultation with a meteorology faculty member and, when appropriate, a member of the staff of an off-campus firm. May be repeated to a maximum of 6 credits. The practicum may not be substituted for a non-elective course in the major. Prerequisite: permission of the department chair.

DEPARTMENT OF MATHEMATICAL SCIENCES

Charles L. Byrne, Chairperson

Professors: Charles L. Byrne, Alan W. Doerr, M. Brendan Fleming, Raoul M. Freyre, Lee K. Jones, Thomas F. McElligott, Gerard A. Paquette, Mary Beth Ruskai, Bernard Shapiro, Virginia S. Taylor, I. Jacob Weinberg

Associate Professors: Donald L. Ameen, Leonard E. Andrusaitis, Pasquale Condo, David V. Finch, Enrique Gonzalez-Velasco, Michael Grossman, Gerald Kaiser, Alan Kaplan, Thomas G. Kudzma, Kenneth M. Levasseur, Yuly Makovoz, Guntram B. Mueller, Alexander A. Olsen, Shelley L. Rasmussen, Alexander Samarov, Ashot A. Shaginyan, Stanley L. Spiegel, Marvin E. Stick, Arthur D. Talkington, Joyce W. Williams

Assistant Professors: Susan F. Assmann, Edward F. Baldyga, Mary E. Flahive, Ann Marie Hurley, Fernando R. Lasaga, Rida M. Mirie, Stephen A. Pennell, Kevin M. Ryan, Richard S. Segall, Richard E. Winslow, Edwin Wolf

The Department of Mathematical Sciences offers a major in mathematics which leads to the Bachelor of Science degree with options in applied mathematics, computer, and statistics.

The Department offers a minor in mathematics to students majoring in other fields.

Mathematics Major

The major in mathematics is designed to provide a sequence of courses which will acquaint the student with the important concepts underlying the main branches of mathematics. The mathematics major is offered under requirements of the College of Pure and Applied Sciences for the Bachelor of Science degree. The mathematics major curriculum exceeds the minimal recommendations of the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America for college mathematics majors programs. It provides a valuable background for subsequent graduate study in mathematics, in related disciplines, and in education. It also prepares students for employment in business and industry. Each mathematics major is required to select one area of emphasis for study in depth. The areas are applied mathematics, computer, and statistics.

Elementary and Secondary Education Program

For those students interested in teaching, the College of Education offers a graduate degree program designed to prepare elementary teachers and secondary teachers in mathematics.

This year-long program (September to June) provides the course work and the experience required for certification in Massachusetts and in thirty-three other states.

See the Graduate School Catalog for requirements for admission. Additional information may be obtained from the College of Education.

Mathematics Courses for Secondary Education Certification

Calculus, including Analytic Geometry	9-12
Discrete Structures I and II	6
Probablilty and Statistics	3
Computer Area Mathematics Courses	9
Other Approved Mathematics Courses (No more than 6 credits of Pre-Calculus)	6-9
Total	**36**

Approved substitutes for Discrete Structures I:
Linear Algebra I
Real Analysis I

Approved substitutes for Discrete Structures II:
Number Theory
Abstract Algebra
Linear Algebra II

The program assumes the candidate is already proficient in the usual high school courses of algebra, geometry, and trigonometry. Any deficiencies would need to be addressed within the "other approved mathematics courses" or as prerequisites for the program.

This program of courses satisfies the Massachusetts Secondary Education Mathematics Field of Knowledge Certification Requirement. Consult the College of Education for additional requirements for certification.

Cooperative Education Program

The Department of Mathematical Science has formally adopted the voluntary University Cooperative Work Experience Program. This Program provides learning experiences for mathematics majors in their chosen careers, helps them to define their career goals, and assists them in meeting their educational expenses. Students who are interested in this program should consult the chairperson of the department.

Honors in Mathematics

Honors in the Major Field

Selected mathematics students may qualify for honors in the major field. University requirements for major field honors are described elsewhere in this publication under the heading "Academic Policies: Academic Honors." Superior students are given the opportunity to pursue a more intensive program. The formal granting of honors provides recognition of outstanding interest and performance in mathematics. Students who currently are registered for, or who have completed, 92-222, Linear Algebra II, may petition for admission to the honors program. Interested students should consult with the chairperson of the department.

Pi Mu Epsilon

Pi Mu Epsilon is a national honorary mathematics fraternity. Our chapter is Massachusetts Delta. Election to the fraternity is based on overall cumulative grade-point average and a separate cumulative grade-point average for mathematics courses only. For more information see Dr. Taylor, OS 223. Sophomores, juniors, seniors, and graduate students are all eligible for election.

Mathematical Achievement Awards

These are given to the top graduating seniors with a major in mathematics. Ordinarily three students are chosen to receive these awards.

Five year B.S./M.S. Program in Mathematics

A. Applied Mathematics Option
B. Computer Option
C. Statistics Option

General description: The five year B.S./M.S. program consists of 122 hours of undergraduate credit and 30 hours of graduate credit. The 122 hours of undergraduate credit must satisfy all the requirements for an undergraduate degree in mathematics, and the 30 hours of graduate credit must satisfy all the requirements for a Master of Science degree in the chosen option. The options are applied mathematics, computer, and statistics.

One advantage of the program is that it makes it easier to finish both the B.S. degree and the M.S. in a total of five years. A second advantage is that by starting to select graduate courses as early as the junior year and spreading the 30 hours of graduate credit over a three year period one usually has a much wider selection of graduate courses from which to choose. Not all graduate courses are offered on a yearly basis.

Eligibility: Any student who has completed three semesters of the undergraduate mathematics program with a grade point average overall and in mathematics of 3.0 or better is eligible for the program. Advanced placement students may apply earlier.

Interested students should make an appointment with the program coordinator. Students who decide to apply for admission to the program, must send a letter of application to the graduate coordinator, Department of Mathematical Sciences, University of Lowell. A committee of the graduate faculty will review your record and notify you of their decision.

With the approval of the Department Graduate Selection Committee the student will file a formal application to the Graduate School during the second semester of the junior year. The student need not have taken the GRE examination. The committee decision will be based on: (a) overall grade point average, (b) grade point average in selected subjects, (c) recommendations by department faculty, and (d) a one year minimum residency at the University of Lowell. Upon approval and recommendation by the Dean of the Graduate School the student may officially become a provisional graduate student in the second semester of the senior year.

Program Planning:

The expectation is that the student will begin electing graduate courses during the junior year. The Graduate School catalog has a complete description of the requirements and options for the M.S. degree. Two approved 400-level courses (six credit hours) may be counted toward the 30 hours of graduate credit required, but these courses may not be included in those used for the undergraduate degree.

Summary Of Degree Requirements

1. University Core Requirement 26-29*

Physical Education	2
English Composition	6
Area Distribution (6 courses—18 credits)	18
Area I (6-12)**	
Area II (6-12)**	
Human values	3

2. Major Field Requirements

A. Mathematics	**60**
1. Required Courses	45
92-131 Calculus I or 92-133 Honors Calculus I	4
92-132 Calculus II or 92-134 Honors Calculus II	4
92-221 Linear Algebra I	3
92-222 Linear Algebra II	3
92-231 Calculus III or 92-233 Honors Calculus III	3
92-234 Differential Equations	3

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* A minimum of two courses and six credits must be presented in each of the Areas I and II plus two additional courses (six credits) selected from either or both of these areas. These courses must be selected from an approved list which will be published each semester prior to registration.

** The core requirements can be satisfied within 26 credits if the course selected to satisfy the human values requirement is also an approved Area I or II course.

92-265 Pascal Programming	3
92-305 Introduction to Real Analysis I	3
92-306 Introduction to Real Analysis II	3
92-307 Probability and Mathematical Statistics I	3
92-308 Probability and Mathematical Statistics II	3
92-411 Complex Variables I	3
92-421 Abstract Algebra I	3
92-450 Mathematical Modeling Seminar	3

2. Option Requirements and Electives 15
(One option must be completed.)

Options:

a) Acturial Mathematics: Four courses including at least two at the four hundred level:

92-362 Numerical Analysis I
92-381 Operations Research I
92-382 Operations Research II
92-409 Demography
92-416 Theory of Interest
92-417 Acturial Mathematics
92-452 Statictical Theory
92-483 Applied Statistical Methods

b) Applied Mathematics:

Four courses, including at least one course in numerical analysis or methods.

92-301 Introduction to Applied Mathematics I
92-362 Numerical Analysis I
92-403 Problems in Signal Analysis I
92-404 Problems in Signal Anlaysis II
92-412 Complex Variables II
92-442 Boundary Value Problems
92-443 Theory of Ordinary Differential Equations
92-454 Numerical Analysis II
92-505 Introduction to Discrete Mathematics
92-512 Complex Analysis II
92-563 Numerical Analysis
92-564 Numerical Algebra
92-571 Optimization I
92-580 Combinatorics
92-581 Graph Theory
92-584 Stochastic Processes
Plus any 500-level courses approved for the applied mathematics option for the M.S. degree.

c) Computer:

92-360 Introducion to Data Structures
92-455 Assembly Language Programming I
Plus two courses chosen from:
92-362 Numerical Analysis I

92-371 Elementary Number Theory
92-454 Numerical Analysis II
92-465 Formal Languages
92-468 Minicomputer Principles and Applications
92-471 Introduction to the Design and Analysis of Algorithms
92-505 Introduction to Discrete Mathematics
92-560 Data Structures
92-563 Numerical Analysis
92-564 Numerical Algebra
92-565 Formal Languages
92-569 Computer Construction Techniques
92-571 Optimization I
92-575 Analysis of Algorithms
92-580 Combinatorics
92-581 Graph Theory
92-589 Software Program Management
92-591 Statistical Modeling and Data Analysis
Plus any 500-level courses approved for the computer option for the M.S. degree.

d) Statistics:

92-452 Intermediate Mathematical Statistics
Plus three courses chosen from:
92-362 Numerical Analysis I
92-413 Statistical Sampling
92-483 Applied Statistical Methods
92-485 or 92-584 Stochastic Processes
92-505 Introduction to Discrete Mathematics
92-580 Combinatorics
92-581 Graph Theory
92-582 Time Series Analysis
92-591 Statistical Modeling and Data Analysis
92-592 Multivariate Statistical Modeling
Plus any 500 level courses approved for the statistics option for the M.S. degree.

e) General: Four courses selected from the above option lists including at least two courses at the 400 level or above.

Elective: In addition to the above, one mathematics course which may be any mathematics course except: 100 level courses, 92-201, 92-203, 92-207, 92-208, 92-209, 92-302, 92-311, 92-317, 92-383, 92-385, and 92-386.

B. Supporting Sciences **16**

Eight credits in approved laboratory science courses distributed to comform to the College requirement are required.

At least one year of Physics is strongly recommended.

Approved sequences:

Biological Sciences: 81-111, 81-112, 81-113, 81-114
Chemistry: 84-121, 84-122, 84-123, 84-124
Geology: 89-121 and 89-123 plus 89-316 and 89-318, or 89-251 and 89-253 or 89-208 and 89-210, or 89-203 and 89-205, or 89-232 and 89-234

Life Sciences: 83-101, 83-102, 83-103, 81-104
Physics: 95-141, 95-144, 96-141, 96-144; or 95-201, 95-202, 96-103, 96-104
Radiological Sciences: 98-401, 98-402, 98-403

Other sequences may be approved, but no more than 8 credits in life science may be applied to this requirement.

C. Technical and Scientific Writing 3

D. Minors and Electives 14-17

1. Minors
A minor may be elected in another department. The following minors are available in the College of Pure and Applied Science: Biological Sciences, Chemistry, Geology, Physics, and Radiological Health Physics.

2. The courses making up the electives and/or minor
   a) must bear a course number prefix other than 90 or 92.
   b) may be from the same departments as courses satisfying the core requirements.
   c) must not be on the following list of courses which overlap or duplicate mathematics courses: 16-228, 16-420; 64-211, 64-212, 66-204; 80-161, 80-162, 80-227, 80-398, 80-499

3. Minimum Credit Requirement 122

SAMPLE COURSE OF STUDY FOR MATHEMATICS (Bachelor of Science)

Freshman Year

Fall Semester		Spring Semester	
92-131 Calculus I	4	92-132 Calculus II	4
92-265 Pascal Programming	3	95-144 Physics II	3
95-141 Physics I	3	96-144 Physics II Lab	1
96-141 Physics I Lab	1	42-102 College Writing II	3
42-101 College Writing I	3	Elective (Non-Math)	3
39- Physical Education	1	39- Physical Education	1
	15		15

Sophomore Year

Fall Semester		Spring Semester	
92-231 Calculus III	4	92-234 Differential Equations	3
92-221 Linear Algebra I	3	92-222 Linear Algebra II	3
42-225 Technical Writing	3	Science	3
Science	3	Science Lab	3
Science Lab	1	Elective (Area I)	1
Elective (Area I)	3	Elective (Non-Math)	3
	17		16

Junior Year

Fall Semester		Spring Semester	
92-305 Real Analysis I	3	92-306 Real Analysis II	3
92-307 Prob & Stats I	3	92-308 Prob & Stats II	3
92- Math Option (300 or above)	3	92- Math Option (300 or above)	3
Elective (Area II)	3	Elective (Area II)	3
Elective (Non-Math)	3	Elective (Human Values)	3
	15		15

Senior Year

Fall Semester			Spring Semester		
92-411	Complex Variables I	3	92-450	Math Modeling Seminar	3
92-421	Abstract Algebra I	3	92-	Math Option (400 or above)	3
92-	Math Option (400 or above)	3	92-	Elective (Math)	3
	Elective (Area I or II)	3		Elective (Area I or II)	3
	Elective (Non-Math)	3		Elective (Non-Math)	3
		15			15

SAMPLE COURSE OF STUDY FOR MATHEMATICS: ACTUARIAL OPTION (Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
92-131	Calculus I*	3	92-132/134	Calculus II*	3
	Science	3		Science	3
	Science Lab	1		Science Lab	1
42-101	College Writing I	3	42-102	College Writing II	3
92-265	Pascal Programming	3		Elective (Non-Math)	3
39-	Physical Education	1	39-	Physical Education	1
		14			14

Sophomore Year

Fall Semester			Spring Semester		
92-231/233	Calculus III*	3	92-234	Differential Equations	3
92-221	Linear Algebra I*	3	92-222	Linear Algebra II*	3
	Science	3		Science	3
	Science Lab	1		Science Lab	1
42-225	Technical Writing	3		Elective (Non-Math)	3
64-201	Economics	3	64-202	Economics II	3
		16			16

Junior Year

Fall Semester			Spring Semester		
92-305	Real Analysis I	3	92-306	Real Analysis II	3
92-307	Prob. & Stats. I**	3	92-308	Prob. & Stats. II	3
60-201	Principles of Accounting I	3	60-202	Principles of Accounting II	3
92-	Math Elective	3	92-	Math Option 300 or above	3
	Area II Elective	3		Area II Elective	3
60-362	Business Law	3		Human Values Elective	3
		18			18

Senior Year

Fall Semester			Spring Semester		
92-411	Complex Variables I	3	92-450	Math Model Seminar	3
92-421	Abstract Algebra I	3	92-	Math Option 300 or above***	3
92-	Advanced Statistice Course**	3	92-	Math Option 400 or above***	3
	Area I or II Elective	3		Area I or II Elective	3
60-201	Accounting I	3	60-202	Accounting II	3
		15			15

* Requirement for Actuarial Exam 1.

** Requirement for Actuarial Exam 2.

*** Applied Statistics, Numerical Analysis, and Operations Research are required courses for Actuarial Exam 3.

SAMPLE COURSE OF STUDY FOR MATHEMATICS: APPLIED MATHEMATICS OPTION

(Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
92-131	Calculus I	4	92-132	Calculus II	4
92-265	Pascal Programming	3	95-144	Physics II	3
95-141	Physics I	3	96-144	Physics II Lab	1
96-141	Physics I Lab	1	42-102	College Writing II	3
42-101	College Writing I	3		Elective (Non-Math)	3
39-	Physical Education	1	39-	Physical Education	1
		15			15

Sophomore Year

Fall Semester			Spring Semester		
92-231	Calculus III	4	92-234	Differential Equations	3
92-221	Linear Algebra I	3	92-222	Linear Algebra II	3
	Science	3		Science	3
	Science Lab	1		Science Lab	1
42-225	Technical Writing	3		Elective (Area I)	3
	Elective (Area I)	3		Elective (Non-Math)	3
		17			16

Junior Year

Fall Semester			Spring Semester		
92-305	Real Analysis I	3	92-306	Real Analysis II	3
92-307	Prob & Stats I	3	92-308	Prob & Stats II	3
92-	Elective (Mathematics)	3	92-	Math Option (300 or above)	3
	Elective (Area II)	3		Elective (Area II)	3
	Elective (Non-Math)	3		Elective (Human Values)	3
		15			15

Senior Year

Fall Semester			Spring Semester		
92-411	Complex Variables I	3	92-450	Math Modeling Seminar	3
92-421	Abstract Algebra I	3	92-	Math Option (300 or above)	3
92-442	Boundary Value Problems	3	92-	Math Option (300 or above)	3
	Elective (Area I or II)	3		Elective (Area I or II)	3
	Elective (Non-Math)	3		Elective (Non-Math)	3
		15			15

SAMPLE COURSE OF STUDY FOR MATHEMATICS: COMPUTER OPTION (Bachelor of Science)

Freshmen Year

Fall Semester			Spring Semester		
92-131	Calculus I	4	92-132	Calculus II	4
92-265	Pascal Programming	3	42-102	College Writing II	3
95-141	Physics I	3	95-144	Physics II	3
96-141	Physics I Lab	1	96-144	Physics II Lab	1
42-101	College Writing I	3	39-	Physical Education	1
39-	Physical Education	1		Elective (Non-Math)	3
		15			15

Sophomore Year

Fall Semester			Spring Semester		
92-231	Calculus III	4	92-234	Differential Equations	3
92-221	Linear Algebra I	3	92-222	Linear Algebra II	3
	Science	3	92-360	Data Structures	3
	Science Lab	1		Science	3
42-225	Technical Writing	3		Science Lab	1
	Elective (Area I)	3		Elective (Area I)	3
		17			16

Junior Year

Fall Semester			Spring Semester		
92-305	Real Analysis I	3	92-306	Real Analysis II	3
92-307	Prob & Stats I	3	92-308	Prob & Stats II	3
92-362	Numerical Analysis I	3	92-455	Assembly Language Prog.	3
	Elective (Area II)	3		Elective (Area II)	3
	Elective (Non-Math)	3		Elective (Human Values)	3
		15			15

Senior Year

Fall Semester			Spring Semester		
92-411	Complex Variables I	3	92-450	Math Modeling Seminar	3
92-421	Abstract Algebra I	3	92-	Math Option (400 or above)	3
92-	Math Option (400 or above)	3		Elective (Area I or II)	3
	Elective (Area I or II)	3		Elective (Non-Math)	3
	Elective (Non-Math)	3		Elective (Non-Math)	3
		15			15

SAMPLE COURSE OF STUDY FOR MATHEMATICS: STATISTICS OPTION (Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
92-131	Calculus I	4	92-134	Calculus II	4
92-265	Pascal Programming	3	95-144	Physics II	3
95-141	Physics I	3	96-144	Physics II Lab	1
96-141	Physics I Lab	1	42-102	College Writing II	3
42-101	College Writing I	3		Elective (Non-Math)	3
39-	Physical Education	1	39-	Physical Education	1
		15			15

Sophomore Year

Fall Semester			Spring Semester		
92-231	Calculus III	4	92-234	Differential Equations	3
92-221	Linear Algebra I	3	92-222	Linear Algebra II	3
42-225	Technical Writing	3		Science	3
	Science	3		Science Lab	1
	Science Lab	1		Elective (Area I)	3
	Elective (Area I)	3		Elective Non-Math)	3
		17			16

Junior Year

Fall Semester		Spring Semester	
92-305 Real Analysis I	3	92-306 Real Analysis II	3
92-307 Prob & Stats I	3	92-308 Prob & Stats II	3
92-362 Numerical Analysis I	3	92- Math Option	3
Elective (Area II)	3	Elective (Area II)	3
Elective (Non-Math)	3	Elective (Human Values)	3
	15		15

Senior Year

Fall Semester		Spring Semester	
92-411 Complex Variables I	3	92-450 Math Modeling Seminar	3
92-421 Abstract Algebra I	3	92- Math Option	3
92- Math Option	3	92- Math Option	3
Elective (Area I or II)	3	Elective (Area I or II)	3
Elective (Non-Math)	3	Elective (Non-Math)	3
	15		15

Mathematics Minors

The Mathematical Sciences Department has set up minors for students not majoring in mathematics. A student who successfully completes the coursework gains depth in mathematics beyond the requirements of the student's major department. Completion of the minor allows the student to receive recognition of this accomplishment. In order to receive a minor the student must file with the registrar an academic petition approved by the Mathematical Sciences Department. This should be done immediately after registration for the courses that will complete the minor.

General Minor

A minor in mathematics consists of 18-24 credits chosen from the mathematics major core and option lists. At least 9 of such credits must be in mathematics courses not required by the student's major department. A minimum of 6 credits must be in courses on or above the 300 course level. Linear Algebra II may be substituted for 1 of the 300 level courses.

Computer Option

The computer minor consists of 7 courses and 21 semester hours as specified below. Requirements:

1. One 200-level calculus course.
2. One computer programming course as required by the student's major.
3. 92-265 Pascal Programming.
4. One of:
   92-455 Assembly Language I (formerly 92-367)
   92-468 Minicomputer Principles and Applications.

5-7. Any three computer courses from an approved list maintained in the Mathematical Sciences Department office.

This option is not available to students majoring in mathematics or computer science.

Mathematics (Course Prefix: 92)

92-111 MATHEMATICAL PERSPECTIVES **I(3,0)3**
An introduction to the nature of mathematics, providing insights into what mathematics is, what it accomplishes, and how it is pursued as a human enterprise. Concepts and relevance to modern experience will be stressed with topics drawn from areas such as inductive and deductive reasoning, number systems, algebra, geometry, probability, and statistics. Prerequisite: Two years of high-school algebra. No credit toward a degree in science or engineering.

92-113 CONCEPTS IN ALGEBRA **I(3,0)3**
An intensive one semester course for students planning to take calculus or statistics courses who require additional preparation. Topics taken from algebra, trigonometry, and plane analytic geometry. A student may not take both 92-113 and 92-121. No credit toward a degree in science or engineering.

92-115 COLLEGE TRIGONOMETRY **II(3,0)3**
Angles and their measure, the trigonometric functions, solving triangles, law of sines, law of cosines, circular functions and their graphs, trigonometric identities. No credit toward a degree in science or engineering.

92-121 PRE-CALCULUS MATH **I,II(2,2)3**
Review of algebra: operations on the real numbers, exponential notation, factoring, radical notation, and rational exponents. Linear and fractional equations, inequalities, radical equations, and quadratic equations. Relations, functions, graphs, symmetry, straight lines, circles, parabolas, systems of equations, mathematical models, graphs of trigonometric functions. No credit toward a degree in science or engineering except for I.T. majors.

92-122 DIFFERENTIAL CALCULUS **II(2,2)3**
Computer programing in BASIC on the University computer. Differential calculus: limits, continuity, derivatives, differentials, higher-order derivatives, implicit differentiation, maxima and minima of functions, and applications of derivatives to business and economics. Prerequisite: 92-121. Primarily for students in management science.

92-124 PRE-CALCULUS MATHEMATICS FOR SCIENCE AND ENGINEERING **II(3,0)3**
A review of some high-school mathematics for prospective calculus students. The following topics are included: fractions, exponents and radicals; relations, functions, and graphs; exponential and logarithmic functions; trigonometry and the trigonometric functions; imaginary and complex numbers; polynomials and rational functions; the conic sections. No credit toward a degree in science or engineering.

92-131 CALCULUS I **I,II(4,0)4**
Analytic geometry including lines, circles and conic sections; functions, limits, derivatives, integrals, curve sketching, areas.

92-132 CALCULUS II **II(4,0)4**
Differentiation and integration of trigonometric, exponential, logarithmic, and hyperbolic functions. Parametric equations, polar coordinates, arc length, methods of integration, applications. Prerequisite: 92-131.

92-133 HONORS CALCULUS I **I(4,0)4**
Functions, limits, derivatives, continuity, elementary functions, extrema, applications. Riemann integral, fundamental theorem of calculus. Emphasis on both theory and applications.

92-134 HONORS CALCULUS II **II(4,0)4**
Applications of the integral, antidifferentiation techniques, improper integrals, conics, polar coordinates and equations, parametric equations, plane vectors. Prerequisite: 92-133 with a grade of C or better.

92-201 INTEGRAL CALCULUS **I(3,0)3**
Exponential and logarithmic functions, area under a curve, fundamental theorem of calculus, integration by parts, areas between curves, applications of integration to business and economics, differential equations, multivariable calculus, maxima and minima using Lagrange multipliers. Matrix algebra: matrix operations, inverse of a matrix, solving simultaneous equations with matrices. Prerequisite: 92-122.

92-202 MICROCOMPUTERS AND APPLICATIONS SOFTWARE **I,II(2,1)3**
An introduction to the processing of information by microcomputers. Topics include: computer logic, memory, input/output, and use of applications software including spreadsheets, word processors, graphics, and data bases.

92-203 MATHEMATICS OF MUSIC **I,II(3,0)3**
Review of algebra and logarithms: application to the construction of musical scales (Pythagorean, tempered, mean-tone and just); loudness levels and decibels; review of trigonometry; application to the analysis and synthesis of musical sound from harmonics; elementary signal processing; hearing and the ear. Harmonic synthesis is demonstrated on a digital synthesizer coupled to an oscilloscope. Prerequisites: algebra and trigonometry.

92-207 MATHEMATICAL TECHNIQUES OF PHYSICS I **I(4,0)4**
Hyperbolic functions, polar coordinates, vectors and parametric equations, solid geometry and vectors, partial differentiation, multiple integrals. For physics majors only.

92-208 MATHEMATICAL TECHNIQUES OF PHYSICS II **II(4,0)4**
Infinite series, differential equations: first order, linear, and power series solutions. Vector differential calculus, vector fields. The integral theorems of Green, Gauss, and Stokes. Physics majors only. Prerequisite: 92-207.

92-209 INTRODUCTION TO BASIC **I,II(3,0)3**
An introduction to the processing of information by computer. Computer logic, memory, input/output, timesharing, flowcharting techniques and programming in the BASIC language. Prerequisite: 92-121 or equivalent. (No credit for students who have 2 or more credits in a college level programming course.) Credit given for no more than one of thecourses 92-209, 92-219, and 92-242.

92-216 HISTORY OF MATHEMATICS **I(3,0)3**
An investigation of creative mathematics through the lives of mathematicians from classical times to the present.

92-219 BASIC PROGRAMMING **I(3,0)3**
Programming in BASIC including nested loop, subscripted variables, string manipulation, subroutines, and advanced programming techniques. Prerequisite: Working knowledge of some other programming language. Credit given for no more than one of the courses 92-209, 92-219, and 92-242.

92-221 LINEAR ALGEBRA I **I(3,0)3**
Elementary set theory and solution sets of systems of linear equations. An introduction to proofs and the axiomatic methods through a study of the vectorspace axioms. Linear analytic geometry. Linear dependence and independence, subspaces, basis, inner products, matrix algebra.

92-222 LINEAR ALGEBRA II **II(3,0)3**
Linear transformations, linear operators, change of basis, and the diagonalization problem, quadratic forms, convex sets and geometric programming, input/output models for an economy, Markov chains, and other applications of linear algebra. Prerequisites: 92-221 and 92-132/134.

92-231 CALCULUS III **I(4,0)4**
Infinite series, vectors and analytic geometry in space, partial derivatives, multiple integrals. Prerequisite: 92-132.

92-233 HONORS CALCULUS III **I(4,0)4**
Infinite series, vectors and analytic geometry in space, partial derivatives, multiple integrals, Jacobians, Stokes' theorem. Prerequisite: 92-134 with a grade of C or better.

92-234 DIFFERENTIAL EQUATIONS **II(3,0)3**
The classification and solution of ordinary differential equations of the first order and higher orders. The Laplace transform and applications. Prerequisite: 92-132/134.

92-236 INDIVIDUALIZED DIFFERENTIAL EQUATIONS **II(3,0)3**
First and second order differential equations with applications. Series solutions of ordinary differential equations. The Laplace transform and applications. Prerequisite: 92-132/134.

92-263 FORTRAN PROGRAMMING **I,II(2,1)3**
Programming principles of FORTRAN including input/output, arithmetic and control statements, arrays, functions, and subroutines. Structured programming will be emphasized. Students will process several programs on the University computer.

92-265 PASCAL PROGRAMMING **I,II(3,0)3**
An introduction to computer programming including the elements of algorithm design and data structures. The Pascal language will be used. Topics covered include: algorithm development by step-wise refinement, language control structures, functions and procedures, the standard data types, scalar data types, and an introduction to structured types. The student will process a number of programs on the University computer.

92-301 INTRODUCTION TO APPLIED MATHEMATICS I **I(3,0)3**
Vector analysis, vector theorems, series solutions of ordinary differential equations, boundary value problems. Fourier series, partial differential equations of physics and engineering. Prerequisite: 92-231/233 and 92-234.

92-302 INTRODUCTION TO APPLIED MATHEMATICS II **II(3,0)3**
Complex variables: complex numbers, complex functions, complex integration, contour integration. Numerical analysis: linear equations, interpolation, numerical derivatives and integrals, numerical solution of differential equations. Prerequisite: 92-231/233, 92-234, and knowledge of a high level programming language.

92-305 INTRODUCTION TO REAL ANALYSIS I **I(3,0)3**
Real and complex number systems. Sequences and series of complex numbers. Theory of metric spaces: completeness, compactness, continuity, uniform continuity. Differentiability of functions, Taylor's theorem. Prerequisite: 92-221 and 92-134.

92-306 INTRODUCTION TO REAL ANALYSIS II **II(3,0)3**
Sequences and series of functions. Uniform convergence, elementary functions, functions between Euclidean spaces, the derivative as a linear map, the Jacobian inverse function theorem, implicit function theorem, Taylor's theorem. Integration of real valued functions on Euclidean space, fundamental theorem of the integral calculus, change of variables formula. Introduction to Lebesgue integrals. Prerequisite: 92-305.

92-307 PROBABILITY AND MATHEMATICAL STATISTICS I **I(3,0)3**
Probability, random variables, discrete and continuous densities, expectation and variance, special distributions (binomial, Poisson, normal, gamma, etc.), moment generating functions, joint and conditional distributions, transformations of variables, sampling, central limit theorem. Prerequisite: 92-231/233.

92-308 PROBABILITY AND MATHEMATICAL STATISTICS II **II(3,0)3**
Point estimation and confidence intervals, hypothesis testing, correlation, linear regression, analysis of variance for the one- and two-way design, nonparametric methods, chi-square tests for contingency tables. Prerequisite: 92-307.

92-310 MATHEMATICAL TECHNIQUES OF PHYSICS III **I(4,0)4**
Complex numbers, elementary functions, analytic functions, line integrals, Cauchy's formulas, residue theorem, partial differential equations of physics, separation of variables, eigenvalue problems, Fourier series, Fourier transforms. Prerequisite: 92-208.

92-317 APPLIED MATHEMATICS FOR CHEMICAL ENGINEERS **I(3,0)3**
Vector calculus. Brief review of ordinary differential equations, intensive coverage of Laplace transforms including transformations of step and periodic functions. Series solutions of differential equations including the method of Frobenius and Bessel's equation. Methods of solution of partial differential equations. Numerical methods. Prerequisite: 92-231/233 and 92-234.

92-321 DISCRETE STRUCTURES I **I(3,0)3**
Propositional logic, combinatorics, methods of proof, mathematical systems, algebra of sets, matrix algebra, relations, and functions. Recursion and generating functions. Applications to Pascal and graph theory.

92-322 DISCRETE STRUCTURES II **II(3,0)3**
Graph theory, trees, algebraic systems, Boolean algebra, groups, monoids, automata, finite-state machines, rings and fields. Applications to Pascal, coding theory, logic design, sorting etc. Prerequisite: 92-321.

92-360 INTRODUCTION TO DATA STRUCTURES **II(3,0)3**
Basic concepts of data. Linear lists, strings, arrays, and orthogonal lists, trees and graphs, storage systems and structures, storage allocation and collection, multilinked structures, symbol tables, searching and sorting (ordering) techniques. Prerequisites: 92-221 or 321 and 92-265.

92-362 NUMERICAL ANALYSIS I **I,II(3,0)3**
Theory and application of numerical techniques including error analysis. Solution of linear, nonlinear, and differential equations, interpolation, numerical integration, and curve fitting. Computer solutions are emphasized. Prerequisite: 92-231/233 and knowledge of one computer language.

92-363 INTRODUCTION TO DATA ANALYSIS **I,II(3,0)3**
Computer analysis of data derived from research conducted in physical, social, and life sciences. Data preparation. Data modification, file manipulation, and descriptive statistics using SPSS. Programming ability is not required. Prerequisite: 92-383 or equivalent. Also senior or junior status or permission of chairperson.

92-365 COBOL PROGRAMMING I **I,II(3,0)3**
Programming principles of COBOL (the Common Business Oriented Language), identification, environment, data, and procedures divisions, introduction to compilation procedures. Students will process several problems on the University computer.

92-368 COBOL PROGRAMMING II **I,II(3,0)3**

A continuation of 92-365, this hands-on course requires the student to generate a number of COBOL programs, utilizing the advanced components of the COBOL language. Topics begin with multidimensional tables and include a complete examination of COBOL input/output procedures with random and sequential files, the implementation of the SORT/MERGE and REPORT WRITER modules, and the use of the intercommunication facility for the support of subroutines written in COBOL, FORTRAN and assembly language. Prerequisite: 92-365.

92-369 APPLICATIONS OF MATHEMATICS WITH PASCAL **I,II(3,0)3**

A practical problem solving course to provide the tools needed for software development. Problem specification and organization, algorithms, coding, debugging, the elements of good programming style. Both numeric and non-numeric applications. Primarily for non-mathematics majors. Prerequisites: 92-265 and two semesters of calculus.

92-371 ELEMENTARY NUMBER THEORY **I(3,0)3**

Congruences and Chinese Remainder Theorem. Primitive roots, quadratic reciprocity, approximation properties of continued fractions, Pell's equation. Recent applications of number theory such as primality testing, cryptology, and random number generation. Prerequisite: 92-221 or 92-321.

92-381 INTRODUCTION TO OPERATIONS RESEARCH TECHNIQUES I **I(3,0)3**

The use of decision models in industrial systems. Fundamentals of probability and matrix theory, critical path methods, linear programming, the simplex method, sensitivity analysis, goal programming, transportation and assignment models, integer programming. Prerequisite: 92-132/134 or 92-201.

92-382 INTRODUCTION TO OPERATIONS RESEARCH TECHNIQUES II **II(3,0)3**

A continuation of 92-381. Topics include: inventory control models, Markov analysis, queueing models, dynamic programming, network analysis, and simulation techniques. Prerequisite: 92-381.

92-383 INTRODUCTION TO STATISTICS **I,II(3,0)3**

Sets and probability laws, random variables, mathematical expectations, measure of central tendency and variance, discrete and continuous probability distribution, sampling theory, tests of hypothesis, regression and correlation. May not be taken for credit along with 92-385 or 92-386. May not be used to satisfy mathematics major requirements.

92-385 BIOSTATISTICS **II(3,0)3**

Probability distributions, measure of central tendency and variance, principles of statistical inference, analysis of variance employing nested and block designs, factorial experiments, multi-range comparison tests, analysis of covariance, correlation and regression, nonparametric statistics. The course will include computer methods for solutions of problems. May not be taken for credit along with 92-383 or 92-386. (For biological science majors only.)

92-386 STATISTICS FOR ENGINEERING AND SCIENCE **II(3,0)3**

A one semester course in probability and statistics with applications in the engineering sciences. Probability of events, discrete and continuous random variables, density functions, distributions, estimation, hypothesis testing, regression and correlation. May not be taken for credit along with 92-383 or 92-385. May not be used to satisfy mathematics major requirements. Prerequisite: 92-132/134.

92-403 SIGNAL ANALYSIS I **I(3,0)3**

Signal processing systems, signal representations in the time and frequency domains, digital processing of analog signals, uncertainty and sampling, fast Fourier transforms. Prerequisite: 92-306.

92-404 SIGNAL ANALYSIS II **II(3,0)3**
Band-limited functions, windows and extrapolation, Hilbert transforms, frequency modulation, the uncertainty principle, ambiguity functions, random signals, correlations and spectra. Prerequisites: 92-403 and 92-411.

92-409 DEMOGRAPHY **I(3,0)3**
The study, the methods, and the materials used in the systematic compilation and analysis of population data. Primary focus is on learning sources of data, definitions, collection techniques, population characteristics and dynamics, summarizing and analyzing data, and methods of estimating and projecting local populations. Prerequisite: 92-383 or equivalent.

92-411 COMPLEX VARIABLES I **I(3,0)3**
Complex numbers. Functions of a complex variable, mappings, derivatives, analytic functions, elementary functions. Laurent series, residues and poles, contour integration. Prerequisites: 92-231/233.

92-412 COMPLEX VARIABLES II **II(3,0)3**
Transformations, conformal mappings, boundary conditions, applications in heat conduction, electrostatic potential, and fluid flow, gamma and beta functions, inverse Laplace transform, Riemann surfaces. Prerequisite: 92-411.

92-413 STATISTICAL SAMPLING **(3,0)3**
Introduction to principles and techniques of sampling for the purpose of a survey. Includes: simple random sampling, stratified sampling, systematic sampling, and cluster sampling. Prerequisite: 92-386 or equivalent.

92-416 COMPOUND INTEREST AND ANNUITIES-CERTAIN **I(3,0)3**
Basic concepts and definitions of various types of annuities, valuation of annuities-certain, valuation of securities and sinking funds, determination of yields, and construction of tables. Prerequisite: 92-231/233.

92-417 ACTUARIAL MATHEMATICS **I(3,0)3**
The study of the theory and applications of contingency mathematics in the area of life insurance, annuities, and pensions from both the probabalistic and deterministic approaches. Topical coverage includes life tables, net premiums, expense factors, reserves, nonforfeiture benefits, and dividends. Prerequisite: 92-308 or permission of instructor.

92-418 MATHEMATICAL METHODS OF ENGINEERING ECONOMICS **II(3,0)3**
Analytical presentation of microeconomic theory as a unified body of knowledge. Mathematical treatment throughout. Linear programming, game theory, probabilistic models, input/output analysis, and Bayesian statistics used in problem solution. Prerequisite: 92-231/233.

92-421 ABSTRACT ALGEBRA I **I(3,0)3**
Elementary group theory, groups, cosets, normal subgroups, quotient groups, isomorphisms, homomorphisms, series of groups, the Sylow theorems, free groups and homology groups. Prerequisite 92-221.

92-422 ABSTRACT ALGEBRA II **II(3,0)3**
Elementary ring and field theory, quotient rings and ideals, homomorphisms of rings, rings of polynomials, algebraic extensions, automorphisms of field, separable extensions, Galois theory, introduction to categories and functors. Prerequisite: 92-421.

92-431 TOPOLOGY **I(3,0)3**
This course provides an introduction to the concepts of point-set topology, and to algebraic topology. Included among the topics covered are: metric spaces and topological spaces; continuity, connectedness, and compactness, the fundamental group. Prerequisite: 92-306.

92-442 BOUNDARY VALUE PROBLEMS **I(3,0)3**
Partial differential equations of physics and engineering. Boundary value problems, Fourier series, convergence tests, Sturm-Liouville problems, orthogonal systems and generalized Fourier series, Fourier integrals, and applications. Prerequisite: 92-306 or permission of instructor.

92-443 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS **I(3,0)3**
Differential equations in Euclidean space, existence, uniqueness, and continuation of solutions, autonomous systems and the Poincare-Bendixson theory. Linear and perturbed linear systems, plane systems, the neighborhood of critical points and closed orbits, Liapunov stability, periodic systems and Floquet theory. Prerequisite: 92-305.

92-447 VECTOR CALCULUS FOR SCIENCE AND ENGINEERING **II(3,0)3**
Cylindrical and spherical coordinate systems; curves and surfaces, differential forms, the exterior derivative as a generalization of the gradient, curl, and divergence; Stokes' theorem and its various forms; a simple formulation of Maxwell's equations in terms of differential forms. Prerequisites: 92-222 and 92-231/233.

92-450 MATHEMATICAL MODELING SEMINAR **II(3,0)3**
This course is devoted to studying the application of mathematics in government and industry. It includes numerous case studies which employ the techniques of graphical, optimization, and dynamic modeling. Prerequisite: Senior math major or permission of instructor.

92-452 STATISTICAL THEORY **II(3,0)3**
A survey of topics in mathematical statistics, including those covered in the second actuarial exam. Maximum likelihood estimation, sufficient statistics, completeness and uniqueness, likelihood ratio tests, UMP tests, Rao-Blackwell theorem, non-central chi-squared and F distribution, SPRT, some multivariate distributions. Prerequisite: 92-307.

92-454 NUMERICAL ANALYSIS II **II(3,0)3**
Continuation of 92-362 including: numerical solution of ordinary and partial differential equations, boundary value problems, curve-fitting, error analysis, and computer solutions. Prerequisite: 92-362.

92-455 ASSEMBLY LANGUAGE PROGRAMMING I (Formerly 92-367) **I,II(3,0)3**
Absolute machine language coding and the symbolic programming language; the basic computer instructions including arithmetic, input/output, logic control operations, and data manipulation. The coding of practice problems on a high-speed digital computer. Prerequisite: 92-263 or 92-265.

92-456 ASSEMBLY LANGUAGE PROGRAMMING II (Formerly 92-467) **II(3,0)3**
A continuation of Assembly Language Programming I. Symbolic programming using advanced techniques including macro instructions, indirect addressing, file generation and processing, magnetic tape and magnetic disk applications. Prerequisite: 92-455.

92-459 ARTIFICIAL INTELLIGENCE **I(3,0)3**
State-space representations, state-space search algorithms, problem-reduction representations, and problem-reduction search methods. The student will be required to code and execute a number of programs in LISP. Prerequisite: 92-263 or 92-265, and permission of instructor.

92-461 SYSTEMS SIMULATION AND MODELING **I(3,0)3**
Procedures in model construction and computerized simulation, modeling tools and techniques, model conceptualization and implementation, selected applications of simulation. Prerequisite: 92-263 or 92-265, or equivalent.

92-462 SYSTEMS PROGRAMMING **II(3,0)3**
Basic concepts of assembly programs and compilers, macro-generators, utility programs, supervisors, monitors and high-level languages. Prerequisites: 92-360 and 92-455.

92-465 FORMAL LANGUAGES **I(3,0)3**
Principles of finite automata. Properties of languages accepted by finite automata, context-free grammars and push-down automata, Turing machines and computability. Prerequisite: Pascal.

92-466 THEORY OF COMPUTATION **II(3,0)3**
Computability, undecidability, complexity, Turing machines and the halting problem, elementary recursion theory, the Church-Turing thesis, measures of complexity, the speed-up theorem, proving theorems about programs. Prerequisite: Pascal.

92-468 MINICOMPUTER PRINCIPLES AND APPLICATIONS **II(3,0)3**
Current minicomputer practices covering both hardware and software including basic minicomputer instruction sets, operating systems, assembler and input/output programing, utilities, interrupts, and interfaces. Scientific, industrial and business applications throughout. Prerequisite: 92-263 or 92-265.

92-469 COMPILER CONSTRUCTION TECHNIQUES **I(3,0)3**
Typical compiler organization is studied including symbol tables, various types of scans, object code generation, error diagnostics, and optimization techniques. Segments of a classroom compiler are written by students. Prerequisites: 92-360 and 92-455.

92-470 DATA COMMUNICATIONS **II(3,0)3**
Analysis and use of remote computing systems including time-sharing, remote-batch, and real-time systems. Design characteristics, applications, data communications, economics and management of such systems. Prerequisites: 92-265 and 92-360.

92-471 INTRODUCTION TO THE DESIGN AND ANALYSIS OF ALGORITHMS
I(3,0)3
Basic steps in developing an algorithm: correctness, algorithm design techniques such as hill climbing, subgoals, heuristics, backtracking, branch and bound, recursion, sorting and searching, paging, parallelism, algorithm and program correctness, measures of algorithm efficiency, complexity, and overall effectiveness. Prerequisite: permission of instructor.

92-474 DATA BASE CONCEPTS **II(3,0)3**
An introduction to data base directives, design element of three data bases, architectures, and commercial data bases will be presented. Students will participate in design of a large scale data base application. Administration of the data base. Students will program the basic concepts on a machine. Prerequisites: Two semesters of high-level language, excluding BASIC.

92-477 MANAGEMENT INFORMATION SYSTEMS I **I(3,0)3**
Analysis and evaluation of third generation integrated software systems including hardware for requirements, routine and demand reports, architectural evaluation for integrated business function control and the data base design.

92-478 MANAGEMENT INFORMATION SYSTEMS II **II(3,0)3**
Automated decision-making models, systems user consideration, the economics of MIS including effects on management organization, personnel, and data management. Prerequisite: 92-477.

92-481 OPERATIONS RESEARCH I **I(3,0)3**
General linear programming problem, simplex method, duality and sensitivity analysis, transportation and network problems, dynamic programming, integer (linear) programming, PERT. Prerequisite: 92-221.

92-482 OPERATIONS RESEARCH II **II(3,0)3**
Probability review (moment generating functions and Z-transforms), inventory models, queueing theory, Markov chains, and decision models, nonlinear programming. Prerequisite: 92-481.

92-483 APPLIED STATISTICAL METHODS **I(3,0)3**
The development of statistical techniques without the use of calculus. Analysis of variance, multiple and curvilinear regression, and nonparametric methods. Prerequisite: 92-383 or equivalent.

92-484 STOCHASTIC PROCESSES **II(3,0)3**
Introduction to Poisson processes, exponential models, birth and death processes, Markov chains and processes, renewal theory, queueing theory, and Brownian motion. Prerequisite: 92-307, 92-386, or equivalent.

92-485 QUEUEING THEORY **I(3,0)3**
Single-server queueing systems, queue length, and waiting time, multi-server queueing systems, modeling of telephone systems, interactive computer systems. Prerequisite: 92-386 or equivalent.

Directed Studies

Directed studies courses are available only to mathematics majors and may be elected provided that (1) the material to be covered is not available in any other mathematics course, (2) instructors are willing to undertake a directed studies, and (3) no more than 9 credits in mathematics are acquired through directed studies courses.

92-490 DIRECTED STUDIES IN COMPUTER SCIENCE **I,II(3,0)3**
Individual study for the student desiring more advanced or more specialized work in computer science. May be repeated for a total of 6 semester credits. Course may not be substituted for scheduled offerings. Prerequisite: permission of department chairperson.

92-491 DIRECTED STUDIES IN ANALYSIS **I,II(3,0)3**
Individual study for the student desiring more advanced or more specialized work in analysis. May be repeated for a total of 6 semester credits. Course may not be substituted for scheduled offerings. Prerequisite: permission of department chairperson.

92-492 DIRECTED STUDIES IN ALGEBRA **I,II(3,0)3**
Individual study for the student desiring more advanced or more specialized work in algebra. May be repeated for a total of 6 semester credits. Course may not be substituted for scheduled offerings. Prerequisite: permission of department chairperson.

92-493 DIRECTED STUDIES IN GEOMETRY **(3,0)3**
Individual study for the student desiring more advanced or more specialized work in geometry. May be repeated for a total of 6 semester credits. Course may not be substituted for scheduled offerings. Prerequisite: permission of department chairperson.

92-494 DIRECTED STUDIES IN STATISTICS AND OPERATIONS RESEARCH **I,II(3,0)3**
Individual study for the student desiring more advanced or more specialized work in statistics and operations research. May be repeated for a total of 6 semester credits. Course may not be substituted for scheduled offerings. Prerequisite: permission of department chairperson.

Primarily for Graduate Students

All graduate courses are open to undergraduate students with permission of the instructor

90-553 SYSTEMS SIMULATION **(3-0)3**
Procedures in model construction and computerized simulation, modeling tools and techni-

ques, model conceptualization and implementation, selected applications of simulation. Prerequisite: Knowledge of FORTRAN and assembly language.

90-554 MINICOMPUTER PRINCIPLES AND APPLICATIONS (3,0)3
Current minicomputer practices covering both hardware and software including basic minicomputer instruction sets, operating systems, assembler and I/O programming, utilities, interrupts, and interfaces. Applications to Science and Business. Prerequisite : Assembly Language.

90-555,556 SYSTEM DESIGN AND DEVELOPMENT I,II (3,0)3 (3,0)3
Design and development of computer-oriented data processing systems including the approach requirements of the system, developing the solution, data controls, system controls, system evaluation and reporting to management. Case studies. Prerequisite: Assembly Language and Pascal.

90-577 PROGRAMMING LANGUAGES (3-0)3
An introduction to the formal concepts of programming languages including specifications of syntax and semantics. Examination of programming languages with emphasis on practical applications.

92-501,502 REAL ANALYSIS I,II (3,0)3, (3,0)3
Real and complex number systems, set theory, Bolzano-Weierstrass and Heine-Borel theorems, sequences and series, continuity, differentiation, Riemann integration, sequences and series of functions, functions of several variables, measure and integration.

92-503 MATHEMATICAL ANALYSIS (3,0)3, (3,0)3
The real and complex number systems, Euclidean spaces, countable and uncountable sets, metric spaces: completeness, compactness, connectedness, continuity, uniform continuity, discontinuities, monotone functions, sequences and series of functions, uniform convergence, differentiation with respect to the parameter, change of order of integration.

92-505 INTRODUCTION TO DISCRETE MATHEMATICS (3,0)3
Basic counting rules, permutations and combinations, recurrence relations, asymptotic algorithms analysis, NP-completeness, heuristic algorithms, linear, integer, and dynamic programming, coding theory applications. Prerequisite: Linear Algebra or Discrete Structures.

92-511,512 COMPLEX VARIABLES I,II (3,0)3, (3,0)3
Complex numbers, elementary functions and their geometric representation. Differentiation and integration, power series, singularities, entire and metamorphic functions, periodic functions.

92-513 NUMBER THEORY (3,0)3
Study of primes, congruences, number-theoretic functions, Dirichlet series, quadratic forms and quadratic number fields. Additional topics as time permits.

92-514 CALCULUS FROM AN ADVANCED VIEWPOINT (3,0)3
This course is designed to provide teachers with the background necessary to teach Advanced Placement Mathematics. It is specifically designed for the teacher option.

92-515 COMPLEX ANALYSIS (3,0)3
Differentiation and integration of complex analytic functions, Cauchy's integral theorem and formula, singularities and Laurent series, theory of residues and applications, harmonic functions, conformal mapping. Prerequisite: Mathematical Analysis.

92-521,522 ALGEBRAIC STRUCTURES I,II (3,0)3, (3,0)3
Properties of rings, groups, fields, polynomials over fields, extension rings and fields, vector spaces, codes, and additional applications. Students in the computer option must take 92-321 prior to 92-521.

92-523,524 LINEAR ALGEBRA I,II **(3,0)3, (3,0)3**
Sets and maps, vector spaces and linear maps, the matrix of a linear map, inner product and orthogonality, bilinear maps, triangulation, the spectral theorem.

92-527,528 GEOMETRIES I,II **(3,0)3, (3,0)3**
Transformation in Euclidean Geometry, hyperbolic and inversive geometries, caroms, golden ratio, convexity, theorems of Ceva, Menelaus, and Morley, incidence geometry, collineations, synthetic and analytic projective geometry, cross ratio, polarities, finite geometries, hyperbolic geometry.

92-529 DIFFERENTIAL GEOMETRY **(3,0)3**
Differential geometry involving curves and surfaces in 3-space, curvature, torsion, Frenet equations, intrinsic equations, involutes and evolutes.

92-530,531 APPLIED MATHEMATICS I,II **(3,0)3 (3,0)3**
Matrices, vector analysis, divergence, Green's and Stokes' theorem, series solution of differential equations, boundary value problems, Fourier series and integrals, partial differential equations, separation of variables.

92-537,538 VECTOR AND TENSOR ANALYSIS I,II **(3,0)3, (3,0)3**
The geometry of curves and surfaces, Serre-Frenet formulas, intrinsic equations of a curve, first and second fundamental forms of a surface, divergence, curl, and gradient, tensor algebra, covariant and contravariant differentiation and parallel displacement, applications to differential geometry and selected topics.

92-541,542 DIFFERENTIAL FORMS AND THEIR APPLICATIONS I,II
(3,0)3, (3,0)3
Vector calculus, curves and surfaces, differential forms and multilinear maps, the gradient, curl, and divergence as exterior derivatives, the general Stokes' theorem, applications to electrodynamics and thermodynamics.

92-541,542 FOURIER ANALYSIS AND BOUNDRY VALUE PROBLEMS I,II
(3,0)3, (3,0)3
Fourier series and integrals, orthogonal systems and Sturm-Liouville problems, applications to boundary value problems in rectangular, cylindrical, and spherical coordinates, distributions and their applications. Prerequisite: Mathematical Analysis.

92-543 ORDINARY DIFFERENTIAL EQUATIONS **(3,0)3**
Existence, uniqueness, and smoothness of solutions, the Poincare-Bendixson theory, the neighborhoods of critical points and closed orbits, Liapunov stability, linear and perturbed linear systems. Prerequisite: Mathematical Analysis.

92-545,546 PARTIAL DIFFERENTIAL EQUATIONS I,II **(3,0)3, (3,0)3**
Introduction to partial differential equations in the plane and space, with engineering applications, solution of initial and boundary value problems, complex variables and transform theory.

92-547 INTEGRAL EQUATIONS **(3,0)3**
Exact, iterative, and numerical techniques for the solution of linear Volterra and Fredholm integral equations, theorems for general operators, symmetric kernels, orthogonal system of functions, and the Hilbert-Schmidt theorem, applications.

92-548 MATHEMATICS OF SIGNAL PROCESSING I **(3,0)3**
Representation of signals: Fourier analysis, fast Fourier transforms, orthogonal expansions, transformation of signals: linear filters, modulation, band-limited signals, sampling, uncertainty principle, windows and extrapolation. Prerequisite: Mathematical Analysis.

92-551 CALCULUS OF VARIATIONS **(3,0)3**
The first variational problem: necessary conditions, Euler's equation, generalization to

dependent and independent variables, constraints and Lagrange multipliers, application to dynamics and elasticity, direct methods. Prerequisite: Mathematical Analysis.

92-560 DATA STRUCTURES AND ALGORITHMS I **(3,0)3**
Implementations of lists, stacks, queues, ordered and binary trees, and priority queues. Tree traversals, open and closed hashing, directed graphs: shortest paths and acyclicity, algorithm analysis techniques. Prerequisite: Some mathematical maturity, and Pascal.

92-563 NUMERICAL ANALYSIS **(3,0)3**
Nonlinear equations in one and several variables, numerical differentiation and integration, numerical methods for ordinary differential equations and for the Laplace, heat, and wave equations. Prerequisite: Mathematical Analysis.

92-564 NUMERICAL ALGEBRA **(3,0)3**
Solution of linear systems, eigenvalue, eigenvector problem, fast Fourier Transform, introduction to finite elements, least squares, splines, chebyshev approximation.

92-565 FORMAL LANGUAGES **(3,0)3**
Principles of finite automata, properties of languages accepted by finite automata, context-free grammars and push-down automata, Turing machines and computability. Prerequisite: Pascal.

92-566 THEORY OF COMPUTATION **(3,0)3**
Computability, undecidability, complexity, Turing machines and the halting problem, elementary recursion theory, the Church-Turing thesis, measures of complexity, the speed-up theorem, proving theorems about programs. Prerequisite: Pascal.

92-571 LINEAR OPTIMIZATION **(3,0)3**
Simplex and revised simplex methods, duality, sensitivity analysis, the transportation problem and other applications, degeneracy procedures, computational techniques. Introduction to integer programming.

92-572 NONLINEAR OPTIMIZATION **(3,0)3**
Unconstrained optimization, Lagrange multipliers, Kuhn-Tucker theory, quadratic programming, convex programming, numerical methods.

92-575 DATA STRUCTURES AND ALGORITHMS II **(3,0)3**
Divide and conquer, radix and comparsion sorts, order statistics, optimal binary trees, union-find, balanced trees, graph connectivity, path finding, matrix multiplication, fast Fourier transform, pattern matching, NP-completeness. Prerequisite: Data Structures and Algorithms I.

92-580 COMBINATORICS **(3,0)3**
Generating functions, recurrence relations, inclusion-exclusion, Polya theory, experimental designs (block design), partially ordered sets, applications. Prerequisite: Introduction to Discrete Mathematics.

92-581 GRAPH THEORY **(3,0)3**
Terminology, theorems, alogrithms, and applications of graph theory, trees, circuits, and connectivity, Hamiltonian and Eulerian graphs, shortest routes, matching, network flows, covering, coloring, Ramsey theory. Prerequisite: Linear Algebra or Discrete Structures.

92-582 TIME SERIES ANALYSIS **(3,0)3**
Building models for discrete time series and dynamic systems, and their use in forecasting and control, stationary and non-stationary time series models, model identification, estimation and checking, with applications, Box-Jenkins (ARMA) and other techniques. Prerequisite: permission of the instructor.

92-583 STATISTICAL SAMPLING **(3,0)3**

Simple random sampling, sampling for proportions and percentages and surveys, estimation of sample size, stratified random sampling, ration estimates, regression estimates, systematic sampling. Prerequisite: Probability and Mathematical Statistics I or Statistics for Science and Engineering.

92-584 STOCHASTIC PROCESSES **(3,0)3**

Markov chains and processes, random walks, stationary, independent increments, and Poisson processes, ergodicity, examples (e.g. diffusion, queueing theory, etc.). Prerequisite: Probability and Mathematical Statistics I.

92-585 QUEUEING THEORY **(3,0)3**

Single-server queueing systems, queue length, and waiting time, multi-server queueing systems, modeling of telephone systems, interactive computer systems. Prerequisite: Statistics and Probability.

92-586 CODING THEORY **(3,0)3**

Error correcting and decoding with selected topics from information theory and cryptography, with emphasis on practical applications in data processing, transmission and security, linear block codes, cyclic codes, convolution codes and arithmetic codes, applications from communications and computer science. Prerequisite: Algebraic Structures I.

92-587,588 MATHEMATICAL STATISTICS I, II **(3,0)3, (3,0)3**

Random variables, densities, joint and conditional distributions, expectations, variance, estimation, sufficiency and completeness, hypothesis testing, limiting distributions.

92-590 QUALITY CONTROL AND RELIABILITY **(3,0)**

Introduces statistical concepts in quality control and reliability analysis. Topics include statistical methods useful in quality assurance, control charts, acceptence sampling, probabilistic representations and analyses of lifetime data, measurement and prediction of reliability characteristics. Prerequisite: Probablilty and Mathematical Statistics I or Statistics for Science and Engineering.

92-591 STATISTICAL MODELING AND DATA ANALYSIS **(3,0)3**

Model building via linear regression models, method of least squares, theory and practice, checking for adequacy of a model, examination of residuals, checking outliers, practical hands-on experience in linear model building on real data sets. Prerequisite: Probability, Biostatistics, or Statistics for Engineering and Science.

92-592 MULTIVARIATE STATISTICAL MODELING **(3,0)3**

Nonlinear model building via the method of least squares, discriminant analysis, factor analysis, principal components, profile analysis, canonical correlation, cluster analysis. Hands-on experience of multivariate statistical analysis of real data sets.

92-593 DESIGN OF EXPERIMENTS **(3,0)3**

How to design, carry out, and analyze an experiment to obtain valid results. Randomized block designs, randomization, blocking, matching, analysis of variance and covariance, control of extraneous variables.

92-594 CONTROL THEORY **(3,0)3**

Analytical and numerical methods for optimization of deterministic and stochastic dynamic systems. Prerequisite: Mathematical Analysis.

92-595 INFORMATION THEORY **(3,0)3**

Shannon theory, including information measure, transmission rates, and capacities, elements of coding theory. Prerequisite: Mathematical Analysis.

92-596 FINITE ELEMENTS **(3,0)3**

Mathematical formulations and techniques including an introduction to variational methods.

Examples from solid mechanics, heat transfer, and fluid mechanics. Prerequisite: Mathematical Analysis.

92-597 PROBABILITY AND MATHEMATICAL STATISTICS (3,0)3
Introduction to combinatorics, geometric probabilities, algebra of probabilities, random variables, classic distributions, measure-theoretic axiomatics, analytical methods, limit theorems, statistical methods: sampling, estimation, regression and correlation. Prerequisite: Mathematical Analysis.

92-598 FUNCTIONAL ANALYSIS (3,0)3
Geometry of general metric spaces with an emphasis on Banach and Hilbert spaces, spectral theory of operators, typical applications (e.g. to differential and integral equations, numerical analysis, and quantum mechanics). Prerequisite: Mathematical Analysis.

92-599 APPROXIMATION THEORY (3,0)3
Uniform approximation by polynomials, the Weierstrass and Jackson theorems, characterization of best approximation, least squares approximation, approximation by splines and rational functions. Prerequisite: Mathematical Analysis.

DEPARTMENT OF PHYSICS AND APPLIED PHYSICS

Aram Karakashian, Chairperson

Professors: Albert Altman, Leon E. Beghian, George L. Carr, Gus P. Couchell, James J. Egan, Zoltan Fried, F. Raymond Hardy, Jesse Y. Harris, Lloyd C. Kannenberg, Aram Karakashian, Gunter H. R. Kegel, Anthony Liuzzi, Suresh C. Mathur, Arthur Mittler, David J. Pullen, Walter A. Schier, Kunnat J. Sebastian, Eric Sheldon, Kenneth W. Skrable, Richard W. Stimets, Ye-Yung Teng, Jerry Waldman, Martin Wilner

Associate Professors: Padmanabh Harihar, Barbara Jensen, Thomas V. Marcella, Roger D. McLeod, Walter R. Mellen, Paul J. Ring, Chuen Wong

Assistant Professors: Sergey Broude, George Chabot, Jr., Clayton French, Alexander Sachs

The Department of Physics and Applied Physics offers majors in physics (with options in pure physics, applied physics, and optics) and radiological health physics which lead to the Bachelor of Science degree. The department also offers a minor area of study in physics and minor area of study in radiological health physics.

Transfer Policies and Equivalency Examinations

The policy of the Department of Physics and Applied Physics with regard to course equivalency examinations and transfer of credits is as follows:

The department will give no equivalency examinations.

Upon presentation of a transcript from an institution judged to have equivalent instruction in physics, showing satisfactory performance in a course or courses judged to provide adequate background in the subject, the department will authorize the transfer of credit as a substitute for the appropriate courses offered in the department.

Upon presentation of a transcript from a university or college about which we have inadequate information, or when, due to justifiable extenuating circumstances, no transcript can be provided, the department may authorize the student to take an examination in each of the courses for which the transfer credit is requested. Upon certification by the examiner that adequate comprehension of the subject matter has been demonstrated, the department may recommend that transfer credits be allowed.

Transfer credit in laboratory courses will be allowed only upon presentation of a transcript showing satisfactory completion of a comparable course.

Physics Major

Physics is the study of the fundamental laws of nature which govern the behavior of all matter. The major serves a variety of goals and interests and provides a broad, comprehensive background in both experimental and theoretical physics which will prove useful for science-oriented careers in business and industry, for subsequent graduate work in professional schools of business, education, law, medicine, and public administration, and for continued study at the master's and doctor's levels. Because of the precise and theoretical nature of physics, students who plan to major in this discipline should possess a high level of mathematical competence. Program options permit the student to select a structured curriculum in pure physics which provides rigorous training in both theoretical and experimental physics or a more flexible curriculum in applied physics which allows the student to apply his or her knowledge of physics to another science or to technological and professional fields. Both the pure and the applied physics options provide the essential content of undergraduate physics, and successful completion of either will provide good preparation for graduate work in physics or in one of the fields in which the student may wish to apply his or her physical knowledge.

A supplementary concentration in optics may be elected by students under either the pure or applied physics option. This program provides intensive laboratory and theoretical training in preparation for a career following the BS degree in such rapidly expanding fields as optical instrumentation, metrology, lasers and other optical devices and image processing, and is also suitable for students anticipating graduate study in optics, physics, astronomy, and engineering.

The pure physics option provides the student with a competitive advantage in areas of physics which deal with both theoretical and experimental concepts and hence may prove more immediately valuable to the student who, following graduation, desires to initiate graduate work in physics or to pursue a career in which a broad theoretical and experimental background in physics is required.

The applied physics option consists of a required physics sequence and a supplementary program from an area such as: biology, business administration, chemistry, computer science, engineering, environmental science, optics, radiological health physics, or technology. The applied physics option provides the student who has a clear understanding of career objectives with an early opportunity to integrate personal goals with the study of physics and undoubtedly will have immediate relevancy for the student who desires to pursue a career in research and development or who wishes to initiate graduate studies in any of the applied physics disciplines following the completion of undergraduate studies.

For those students interested in teaching, the College of Education offers a graduate degree program designed to prepare teachers in physics. This academic year program provides the course work and the apprentice teaching experience required for certification in Massachusetts and in thiry-three other states. Admission requirements are in the graduate catalogue. Interested persons may obtain additional information from Dr. Gail M. Carney, Assistant Professor and Director of Field Experiences, College of Education.

Both the pure and applied physics curricula involve common freshman and sophomore years, at the end of which the student is expected to consult his or her faculty advisor and to make a choice of program. The physics major is offered under the requirements of the College of Pure and Applied Sciences for the Bachelor of Science degree. A grade-point average of 2.00 or better in physics is required for graduation.

Summary of Degree Requirements

1. University Core Requirements 26

Physical Education	2
English Composition	6
Area I (Behavioral & Social Sciences)	6-12**
Area II (Fine Arts & Humanities)	6-12**
Area III (Mathematics & Sciences)	Exempt

2. Option in Pure Physics 98

A. Major Field Requirements 86

1. Physics (95 and 96 Prefix)	58
95-141 Physics I	3
95-144 Physics II	3
96-147 Fundamentals of Experimental Physics I (Honors)	2
96-148 Fundamentals of Experimental Physics II (Honors)	2
95-209 Electricity and Magnetism I	4
95-210 Introductory Modern Physics	4
96-258 Physical Instrumentation I	2
96-293 Experimental Physics I	3
96-294 Experimental Physics II	3
95-335 Introductory Quantum Mechanics I	3
95-336 Introductory Quantum Mechanics II	3
95-338 Physical Optics*	3
95-353 Electromagnetism I	3
95-354 Electromagnetism II	3
96-393 Intermediate Physics Laboratory I***	2
96-394 Intermediate Physics Laboratory II***	2
95-413 Mechanics	4
95-421 Statistical Thermodynamics	4
95-461 Topics in Nuclear Physics	3
95-472 Topics in Solid State Physics	3
2. Supporting Science and Mathematics	**28**
84-121 Chemistry	3
84-122 Chemistry	3
84-123 Chemistry Laboratory	1
84-124 Chemistry Laboratory	1
92-131 Calculus I	4
92-132 Calculus II	4
92-207 Mathematical Techniques of Physics I	4
92-208 Mathematical Techniques of Physics II	4
92-310 Mathematical Techniques of Physics III	4

** A minimum of two courses and six credits must be presented in each of Areas I and II. An additional two courses and six credits must be presented in either or both. (Cf. University Core Requirements).

*** Students who complete the designated sequence of the supplementary area in optics may present the laboratory work included in that sequence in lieu of 96-393 and 96-394.

B. Elective Courses:	**12**

Upon approval by their faculty advisor, students may elect courses from the offerings of the University which are suitable to their needs and interests. Students electing additional physics courses must present one additional credit beyond the minimum university requirement for graduation for each credit in physics beyond 60.

3. Option in Applied Physics

A. Major Field Requirements	**77**
1. Physics (95 and 96 Prefix)	49
95-141 Physics I	3
95-144 Physics II	3
96-147 Fundamentals of Experimental Physics I (Honors)	2
96-148 Fundamentals of Experimental Physics II (Honors)	2
95-209 Electricity and Magnetism I	4
95-210 Introductory Modern Physics	4
96-258 Physical Instrumentation	2
96-293 Experimental Physics I	3
96-294 Experimental Physics II	3
80-354 Electricity and Magnetism Applied	4
80-336 Applied Quantum Mechanics I	4
95-338 Physical Optics*	3
96-393 Intermediate Physics Laboratory I***	2
96-394 Intermediate Physics Laboratory II***	2
95-413 Mechanics	4
95-421 Statistical Thermodynamics	4
2. Supporting Science and Mathematics	28
84-121 Chemistry	3
84-122 Chemistry	3
84-123 Chemistry Laboratory	1
84-124 Chemistry Laboratory	1
92-131 Calculus I	4
92-132 Calculus II	4
92-207 Mathematical Techniques of Physics I	4
92-208 Mathematical Techniques of Physics II	4
92-310 Mathematical Techniques of Physics II	4
B. Supplementary Area	**18**

Students pursuing the applied physics option are required to complete 18 credits in a field such as: biology, business administration, chemistry, computer science, engineering, environmental science, mathematics, meteorology, optics, radiological health physics, or technology. If a minor exists in that field, the courses used in the supplementary area shall be among those listed in the minor. In other cases, the courses selected shall conform to the University requirements for a minor, and include at least two courses and six credits at the upper division (300 or above) level.

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* Students electing the supplementary area in optics may substitute 80-338 for 95-338.

*** Students who complete the designated sequence of the supplementary area in optics may present the laboratory work included in that sequence in lieu of 96-393 and 96-394.

Students who select a supplementary area in optics must complete 80-337, 96-337 80-338, 96-338, 96-359, 80-439, and 80-840. Those completing this sequence may present the laboratory work included in the sequence in lieu of 96-393 and 96-394.

C. Elective Courses

Upon the approval of their faculty advisors, students may elect courses from among the offerings of the University which are suitable to their needs and interests. Students electing additional physics courses must present one additional credit beyond the minimum University requirement for graduation for each credit in physics beyond 60.

4. Minimum Credit Requirements 125

Prerequisites for courses of the major field, or courses which are prerequisites for admission to the College of Pure and Applied Sciences may not be credited to requirements for degrees in the College of Pure and Applied Sciences. All Bachelor of Science programs require, as a minimum, 74 credits and 20 courses from the offerings of the College of Pure and Applied Sciences.

SAMPLE COURSE OF STUDY FOR PHYSICS: PURE PHYSICS OPTION (Bachelor of Science)

Freshman Year

Fall Semester			Spring Semester		
42-101	College Writing	3	42-102	College Writing & Lit.	3
84-121	Chemistry I	3	84-122	Chemistry II	3
84-123	Chemistry Laboratory I	1	84-124	Chemistry Laboratory II	1
92-131	Calculus I+	4	92-132	Calculus II+	4
95-141	Physics I+	3	95-144	Physics II+	3
96-147	Fund. of Experimental. Physics I (Honors)	2	96-148	Fund. of Experimental Physics II (Honors)	2
39-	Physical Education	1	39-	Physical Education	1
		17			17

Sophomore Year

Fall Semester			Spring Semester		
92-207	Mathematical Techniques of Physics I	4	92-208	Mathematical Techniques of Physics II	4
95-209	Electricity and Magnetism I	4	95-210	Introductory Modern Physics	4
96-293	Experimental Physics I	3	96-258	Physical Instrumentation I	2
	Elective	3	96-294	Experimental Physics II	3
				Elective	3
		14			16

Junior Year

Fall Semester			Spring Semester		
92-310	Mathematical Techniques of Physics III	4	95-336	Intro. Quantum Mechanics II	3
95-335	Intro. Quantum Mechanics I	3	95-354	Electromagnetism II	3
95-353	Electromagnetism I	3	96-394	Intermediate Physics Lab II	2
96-393	Intermediate Physics Lab I	2		Electives	6
	Elective	3			
		15			14

+ Appropriate honors courses may be substituted.

Senior Year

Fall Semester		Spring Semester	
95-413 Mechanics	4	95-472 Topics in Solid State Physics	3
95-421 Statistical Thermodynamics	4	Electives	9
95-461 Topics in Nuclear Physics	3	95-338 Physical Optics**	3
Elective	3		
	14		15

** Students electing the optics sequence will take 80-338 in the junior year as part of that sequence and may substitute courses in the optics sequence for 96-393 and 96-394.

SAMPLE COURSE OF STUDY FOR PHYSICS: APPLIED PHYSICS OPTION (Bachelor of Science)

Freshman Year

Fall Semester		Spring Semester	
42-101 College Writing	3	42-102 College Writing & Lit.	3
84-121 Chemistry I	3	84-122 Chemistry II	3
84-123 Chemistry Laboratory I	1	84-124 Chemistry Laboratory II	1
92-131 Calculus I +	4	92-132 Calculus II +	4
95-141 Physics I +	3	95-144 Physics II +	3
96-147 Fund. of Experimental Physics I (Honors)	2	96-148 Fund. of Experimental Physics II (Honors)	2
39- Physical Education	1	39- Physical Education	1
	17		17

Sophomore Year

Fall Semester		Spring Semester	
92-207 Mathematical Techniques of Physics I	4	92-208 Mathematical Techniques of Physics II	4
95-209 Electricity and Magnetism I	4	95-210 Introductory Modern Physics	4
96-293 Experimental Physics I	3	96-258 Physical Instrumentation I	2
Elective	3	96-294 Experimental Physics II	3
		Elective	3
	14		16

Junior Year

Fall Semester		Spring Semester	
92-310 Mathematical Techniques of Physics III	4	95-310 Electricity & Magnetism II	4
96-393 Intermediate Physics Lab I	2	80-336 Applied Quantum Mechanics I	4
Electives	9	96-394 Intermediate Physics Lab II	2
		Electives	6
	15		16

Senior Year

Fall Semester		Spring Semester	
95-413 Mechanics	4	80-338 Physical Optics	3
95-421 Statistical Thermodynamics	4	Electives	12
Electives	6		
	14		15

+ Appropriate honors courses may be substituted.

Physics Minor

A minor in physics consists of 24 credits and must include 95-209, 95-245, 95-210, a minimum of 6 credits at the 300-400 level, and a laboratory course in the area of electricity and magnetism.

Radiological Health Physics Major

A description of the program of study in radiological health physics at the Bachelor of Science Degree level is given on the following pages along with sample courses of study for four years. In addition, a combined five year bachelor of science/master of science program is available to selected undergraduates in the radiological health physics major, and this is also described. The Graduate School catalog should be consulted for more detail concerning the combined BS/MS program.

Radiological health physics is the study of radiation and the determination of the basic principles of the interaction of radiation with matter, the analysis of the nature of radiation environments, and the effect of radiation and radioactivity on life processes both on earth and in space. It can also be called radiation protection science and is particularly involved with the effects of radiation on the human body and the control of such radiation. A graduate of this curriculum would enter the profession of health physics, which is devoted to the protection of humans and their environment from potential radiation hazards, while at the same time making it possible for our advancing civilization to enjoy all of the benefits resulting from uses of radiation.

Radiation control in its professional aspects incorporates an understanding of many disciplines. It has common scientific interests with many areas of specialization: biophysics, physics, biochemistry, chemistry, biology, genetics, ecology, nuclear engineering, metallurgy, medicine, physiology, and toxicology. Other aspects of the profession include working knowledge of economics, labor relations, public relations, teaching, philosophy, and administration. The wide spectrum of knowledge required of the health physicist makes this profession both challenging and rewarding.

Health physicists are employed by federal agencies (such as the Nuclear Regulatory Commission and Department of Energy) at research, production, and testing facilities; state, and local government agencies responsible for regulating the use of radioactive materials; the military services; electric utilities operating nuclear power plants; businesses which use radioisotopes or x-ray equipment to detect flaws or defects in manufactured products, prepare or reprocess nuclear fuels, control nuclear wastes, or produce or use radioactive materials or devices; universities (in teaching, research, and equipment monitoring); hospitals and medical centers that use radionuclides, x-ray equipment, and accelerators in the diagnosis and treatment of patients; and consulting firms which advise and service installations that do not employ full-time health physicists.

There are scholarships available for undergraduate students majoring in radiological health physics, which are sponsored by Northeast Utilities Service Company, Hartford, Connecticut; Yankee Atomic Electric Company, Westborough, Massachusetts; Technical Operations, Inc., Boston, Massachusetts; and Boston Edison Company, Boston, Massachusetts. Normally each year twelve (12) $400 scholarships and two (2) $1,000 scholarships are awarded to students finishing the first year of the radiological health physics baccalaureate degree program. Because of the shortage of trained professional personnel in the field of radiation protection, the industries listed above have sponsored these scholarships in order to attract highly qualified young men and women into the much needed field of study of radiation protection sciences. In order to be eligible for the $400 scholarship, a student must successfully complete the first year of study of the radiological health physics program. The two highest ranking students of those who complete the first year successfully will be awarded the $1,000 scholarships.

The radiological health physics students enjoy excellent job opportunities and challenging careers in the radiation protection field upon graduation. Because of concerns relating to radiation and nuclear electrical power generators, the demand for well trained and qualified radiation protection specialists has increased dramatically in recent years. This demand includes qualified staff for the currently operating nuclear power plants and the approximately 70 plants under construction, as well as radiation protection personnel for industry, universities, hospitals, radiation control agencies and for the many other nuclear and radiation facilities. Students may gain valuable applied work experience while also earning much needed money through various summer internship programs at the University of Lowell. They also may gain experience and academic credit through an internship course at the University radiation laboratory. This course is conducted under the direction of the health physics staff who have responsibility for the radiation safety programs at the nuclear reactor facility, accelerator facility, radioisotope research laboratories and x-ray facilities at the University of Lowell. Senior students who have the motivation, interest and ability are encouraged to work on a research project under the direction of staff and faculty of the program.

The research and job experience that the students receive provide excellent preparation for either an applied health physics position or the pursuit of an advanced degree in radiation protection or related fields. The University of Lowell offers, as well as the B.S. Program, both M.S. and Ph.D. programs in radiological sciences and protection and receives research and scholarship support from government and industry. There is an extreme shortage of radiation protection personnel at the present time and this is expected to continue for the next five to ten years. Therefore, the Radiological Health Physics graduates at all degree levels are receiving many high-salaried job opportunities.

FIVE-YEAR B.S./M.S. PROGRAM IN RADIOLOGICAL SCIENCES

In recognition of the need for advanced training beyond the bachelor of science level in radiological sciences, the following represents a program by which outstanding undergraduates can pursue an accelerated five-year course of study leading to the B.S. and M.S. degrees in Radiological Sciences.

1. Undergraduate students who express an interest in this program will be evaluated by the graduate selection committee. Those students deemed commendable by the committee will be advised relative to the correct procedure for successful completion of their B.S Degree, as well as a course of study toward the M.S. degree.
2. The first three years of undergraduate study will be identical to that which is specified for students enrolled in the current four year B.S. program in radiological sciences.
3. During the second semester of the junior year and upon approval and recommendation by the graduate selection committee, the student will file formal application to the Graduate School. This does not require the student to have taken the GRE examination. The committee decision will be based on; (a) overall grade point average, (b) grade point average in selected subjects, (c) recommendations by program faculty, and (d) a one year mimimum residency requirement at the University of Lowell. Upon approval and recommendation by the Dean of the Graduate School, the student may be allowed to pursue graduate studies during the senior year and officially become a provisional graduate student in the first semester of the senior year.

4. During the senior year, the student will be permitted to take up to four graduate-level courses which can be applied towards the M.S. degree. Although advanced undergraduate (i.e., 400 level) courses are acceptable, no more than two such courses will be allowed towards the M.S. degree. It should be emphasized that the total number of credits for the combined degrees must be greater than the minimum number of credits required for both the undergraduate and graduate degrees. As an example, the radiological sciences program requires 128 credits and the University B.S. requirement is 120 credits. The student may, with approval, transfer up to 8 credits toward the M.S. degree.

5. Upon completion of the fourth year of study, assuming that all program and University requirements have been met, the student will be awarded the B.S. degree and may then be recommended for full matriculation status by the graduate selection committee and the Dean of the Graduate School, prior to the fifth year of study. If the student chooses not to continue toward the M.S. degree (or fails the fifth year), this does not alter receipt of the B.S. degree.

6. Although the options exist for taking an overload in any semester and/or registration for one or more summer sessions, they are not a requirement of this program. However, students wishing to gain a full research experience will be encouraged to initiate their research as early as possible (e.g. during the junior to senior year summer session), which is a distinct advantage of this accelerated program.

7. During the fifth year, as in the standard M.S. degree program, the student may undertake: (a) thesis option (9 semester hours of graduate research), or (b) project option (6 semester hours of graduate project). In either case, the student will be required to take two one-credit graduate seminar courses, as well as the other courses required for the M.S. degree in radiological sciences, and must satisfy the 30 credit minimum M.S. degree requirement. Upon completion of all program and graduate school requirements, the student will be awarded the M.S. degree.

Summary of Degree Requirements

1. University Core Requirements	**26**
Physical Education	2
English Composition	6
Area I (Behavioral & Social Sciences)	6-9*
Area II (Fine Arts & Humanities)	6-9*
Area III (Mathematics & Sciences)	(9-11)**

* A minimum of two courses and six credits must be presented in each of the three areas of the University core requirements. An additional three courses and nine credits must be presented from among the three areas of the University core requirement. Students may not present more than three courses and nine credits from the offerings of any one department (except that not more than two courses and six credits may be presented from the offerings of the English Department) and may not present more than four courses and twelve credits in any one distribution area.

** Area III requirements are satisfied by specified science and mathematics courses of the major field requirements for supporting sciences and mathematics.

2. Major Field Requirements 86

A. Radiological Health Physics 50

95-141	Physics I	3
96-147	Fundamentals of Experimental Physics I (Honors)	2
95-144	Physics II	3
96-148	Fundamentals of Experimental Physics II (Honors)	2
95-245	Physics III	3
96-245	Fundamentals of Experimental Physics III	1
98-101	Introduction to Radiological Sciences I	3
98-102	Introduction to Radiological Sciences II	3
98-401	Radiation Safety and Control I	4
98-402	Radiation Safety and Control II	4
98-422	Environmental Radiation and Nuclear Site Criteria	3
98-472	Radiation Biology	3
80-355	Physics of Radiation of Nuclei I	3
98-356	Physics of Nuclei and Radiation II	3
24-231	Nuclear Instrumentation I	3
80-306	Nuclear Instrumentation II	4
98-301	Health Physics Intern.	3

B. Supporting Sciences and Mathematics 36

84-121	Chemistry I	3
84-123	Chemistry Laboratory	1
84-122	Chemistry II	3
84-124	Chemistry Laboratory	1
81-111	Principles of Biology I	3
81-112	Principles of Biology II	3
81-252	Mammalian Physiology	3
81-254	Mammalian Physiology Laboratory	1
92-131	Calculus I or	4
92-133	Honors Calculus I	4
92-132	Calculus II or	4
92-134	Honors Calculus II	4
92-231	Calculus III or	4
92-233	Honors Calculus III	4
92-234	Differential Equations	3
92-386	Statistics for Engineering and Science	3

3. Allied Courses and Electives 18

42-225	Technical & Scientific Writing	3
92-263	Fortran Programming	3
	Electives	12

4. Minimum Credit Requirement 130

Prerequisites for courses of the major field requirements, or courses which are prerequisites for admission to the College of Pure and Applied Sciences, may not be credited to requirements for degrees in the College of Pure and Applied Sciences. All Bachelor of Science programs require, as a minimum, 74 credits and 20 courses from the offerings of the College of Pure and Applied Sciences.

SAMPLE COURSE OF STUDY FOR RADIOLOGICAL HEALTH PHYSICS (Bachelor of Science)

Freshman Year

Fall Semester		Spring Semester	
42-101 College Writing	3	42-102 College Writing & Lit.	3
92-131 Calculus I +	4	92-132 Calculus II +	4
95-141 Physics I +	3	95-144 Physics II +	3
96-147 Fund. of Experimental Physics I (Honors)	2	96-148 Fund. of Experimental Physics II (Honors)	2
98-101 Intro. to Rad. Sciences I	3	98-102 Intro. to Rad. Sciences II	3
39- Physical Education	1	39- Physical Education	1
	16		16

Sophomore Year

Fall Semester		Spring Semester	
84-121 Chemistry I	3	84-122 Chemistry II	3
84-123 Chemistry Lab I	1	84-124 Chemistry Lab II	1
92-231 Calculus III	4	92-234 Differential Equations	3
95-245 Physics III	3	92-263 Fortran Program	3
96-245 Fund. of Exp. Physics III	1	Elective (Area I)	3
42-225 Tech. and Sci. Writing	3	Elective	3
	15		16

Junior Year

Fall Semester		Spring Semester	
24-231 Nuclear Inst. I	3	80-306 Nuclear Inst. II	4
81-111 Princ. of Biology I	3	81-252 Mammalian Physiology	3
80-355 Physics of Rad. and Nuclei I	3	81-254 Mammalian Phys. Lab	1
92-386 Stats. for Eng. & Sci.	3	83-102 Life Science II	3
Elective	3	Elective (Area I)	3
Elective	3	Elective (Area II)	3
	18		17

Senior Year

Fall Semester		Spring Semester	
98-301 Health Physics Intern I	3	98-402 Rad. Safety & Control II	4
98-401 Rad. Safety & Control I	4	98-422 Environmental Radiation	3
Elective (Area I)	3	98-472 Radiation Biology	3
Elective (Area II)	3	Elective (Area I or II)	3
Elective (Area I or II)	3	Elective	3
	16		16

+ Appropriate honors courses may be substituted.

Radiological Health Physics Minor

A minor in radiological health physics consists of a mimimum of 22 credits and must include:

98-101/102 Introduction to Radiological Sciences	6
98-201 or 98-301 Health Physics Internship	3
98-336 Introduction to Health Physics	3
98-422 Environmental Radiation & Nuclear Site Criteria	3
98-44 1 Radioisotope Techniques	3
98-443 Radioisotope Techniques Laboratory	1
98-472 Radiation Biology	3

Applied Physics (Course Prefix: 80)

80-251 THE PHYSICS OF HIGH FIDELITY I,II (3,0)3
This course examines the principles underlying the design of high fidelity system components and recordings. Topics covered include the properties of waves, an analysis of musical sound, principles of static and current electricity, magnetism, electromagnetic waves, and the laws of mechanics. These basic physics ideas will be incorporated into a description of the operating principles of: loudspeakers, preamplifiers and control centers, power amplifiers, turntables, moving-magnet and moving-coil phono-cartridges, open reel, cassette, and cartridge tape recorders, microphones, headphones, four-channel sound systems, equalizers, Dolby and other noise reduction systems, dynamic range expanders, time-delay ambience simulation devices, tuners, and radio broadcasting. The course will enable even the non-science oriented student to evaluate and understand the jargon filled specification sheets for hi-fi equipment. It will therefore entail consumer education useful to anyone contemplating the expenditure of a substantial sum of money on equipment with which he or she may live for many years. A knowledge of elementary high school algebra is desirable.

80-306 NUCLEAR INSTRUMENTATION I (2,4)2
An integrated laboratory and lecture course covering the operating principles and applications of nuclear radiation detectors, associated electronic signal processing equipment, and data analysis techniques. Topics covered include charged-particle, photon, and neutron detection, as well as charged-particle and gamma-ray spectroscopy. The laboratory involves the use of scintillators, photomultiplier tubes, solid state detectors, gas-filled counter, a variety of electronic instrumentation including oscilloscopes, and experiments utilizing the Pinansky Energy Center's 1 MW nuclear reactor. Prerequisites: 98-202 and 98-206.

80-336 APPLIED QUANTUM MECHANICS II (4,0)4
Application of the Schroedinger equation to the study of molecules, solids, quantum statistics, liquid helium II, and nuclei.

80-337 GEOMETRICAL OPTICS I (2,3)4
Properties of light, plane surfaces and prisms, thin and thick lenses, mirrors and stops, matrix methods applied to Gaussian (paraxial) optics, Lagrange-Helmholtz invariant, primary and chromatic aberrations, ray tracing and Abbe's sine condition, basic optical instruments including cameras, telescopes, and microscopes. Prerequisite: 95-209 or 95-245.

80-338 PHYSICAL OPTICS II (3,0)3
Wave nature of light, mathematics of wave motion, electromagnetic theory of light propagation, reflection and refraction, Fresnel coefficients, polarization, interference, Young's experiment, fringe visibility and coherence, various interferometers, Newton's rings and applications, Fraunhofer diffraction by single and multiple apertures and diffraction gratings, Fresnel diffraction. Prerequisite: 80-238.

80-339 ELECTRO-OPTICS I (2,3)4
Optical properties of materials: complex dielectric constant, isotropic and anisotropic media polarization, transmitting materials for visible applications, optical properties of metals. Sources of electromagnetic radiation: photometry, blackbody radiation, emission spectra of atoms and molecules, incoherent high intensity sources and applications, introduction to lasers as coherent light sources. Detectors: introduction to the photoelectric effect, semiconductor physics, photochemistry, application of basic principles to various detectors. Application of the above material to spectrometers and transmitter-receiver systems. Prerequisites: 80-238, 80-338

80-340 IMAGE PROCESSING **II (2,3)4**

Basic physics of television and other imaging systems: representation and manipulation of images in digital form; Fourier analysis and filtering of images: detection of image features such as edges and regions, pattern recognition, three-dimensional visual perception in man and machine; examples of image processing tasks from such areas as medicine, industrial inspection and robotics, laboratory exercises with an image processing system utilizing and Octec 2000 image analyzer and a Data General Nova 4/C Computer. Ability to program a computer is required. Prerequisites: 80-238, 80-338.

80-351,352 THEORY OF OPTICAL INSTRUMENTATION I AND II **(2,3)4**

Advanced geometrical optics, aberration theory, introduction to lens design. Topics to be covered include lens manufacture, ray tracing and imaging, mirrors, prisms, thin lens systems, simple magnifiers, microscopes, telescopes, photometry of optical systems, the eye as an optical instrument, opthalmic instruments, projection systems, photography and photographic lenses, lens testing, diffraction grating spectroscopes and spectrometers, refractometry, fiber optics, interferometry, lasers. Ability to program a computer is required. Prerequisite 80-337.

80-355 PHYSICS OF RADIATION AND NUCLEI **I(3,0)3**

A survey of atomic and nuclear physics directed to an understanding of the basic modern physics utilized in radiological science and nuclear engineering. Material covered includes but is not necessarily limited to the following topics: Classical and relativistic relationships for momentum and energy, mass energy relationships, motion of charged particles in electric and magnetic fields, mass and charge of the electron, atomic mass and isotopes, the photon, the photoelectric effect, the Compton effect, wave particle dualism and probability, absorption of photonsm scattering and scattering cross sections, Rutherford's nuclear atom, atomic spectra and Bohr's theory of the hydrogen atom, emission and absorption spectra and the selection rules, DeBroglie hypothesis, nutron diffraction, the Schroedinger wave equation, the uncertainty principle, systematics and structure of the nucleus, nuclear forces and nuclear models. Prerequisite: 95-144

80-437 APPLIED OPTICS I **I (3,0)3**

Topics in applied optics including geometric optics, optical design, aberration, lens design, radiometry, photometry, ionterferometry, optical testing and evaluation techniques.

80-438 APPLIED OPTICS II **II (3,0)3**

A continuation of the topics initiated in 80-437.

80-447 LASERS **I (2,3)4**

Introductory treatment of lasers and their applications, interaction of radiation with matter including electric and magnetic dipole transitions, the concept of stimulated emission, rate equations, optical resonators, collision and line broadening processes, study of various gaseous and solid state lasers, applications to harmonic generation, holography, and optical modulation techniques. Prerequisite: 95-335 or equivalent.

80-450 OPTICS PROJECT **II (3,0)3**

A project to be completed by either an individual or two students working as a team to design and test an optical system which will involve a synthesis of a substantial number of optics principals and technique.

80-451 FIBER OPTICS **I (2,3)4**

Introduction to optical communications, basic theory of light guiding, propagation characteristics and focusing effect of an optical waveguide, optical sources and detectors for fiber communications, fundamental parameters of optical fibers, fabrication and testing methods for optical fibers. Laboratory experiments will include optical fiber parameter measurements, sensors, connectors, sources and detectors.

80-452 LENS DESIGN **II (2,3)4**

Review of first order optics, aberrations, aperture stops, field stops, first order layout, calculating and plotting aberration values, achromatic objective design, merit functions and automatic optimization, anastigmats, triplets, system evaluation techniques, tolerancing. Laboratory exercises using a mainframe optical design program. Prerequisites: 80-238, 80-351, 80-352.

80-506 NUCLEAR INSTRUMENTATION **II (2-4)4**

Operating principles and applications of nuclear radiation detectors, associated electronic signal processing equipment, data analysis techniques. Topics covered include charged-particle, photon, and neutron detection, plus charged-particle and gamma-ray spectroscopy. Use of scintillators, photomultiplier tubes, solid state detectors, gas-filled counter, oscilloscopes, etc. Prerequisite: 98-208, 24-533.

80-539 ELECTRO-OPTICS **I(2-3)4**

Optical properties of materials, including dispersion, absorption, and anistoropy, blackbody radiation, emission spectra, incoherent radiators, and lasers, photoeffect, semiconductor detectors, photochemistry, and applications to various detectors. Prerequisite: 80-238 or equivalent.

80-547 LASERS **I (2-3)4**

Interaction of radiation with matter; concept of stimulated emission, rate equations, optical resonator, collision and line broadening processes, study of various lasers, applications to harmonic generation, holography, and optical modulation techniques. Prerequisite: 95-335 or equivalent.

80-551 FIBER OPTICS **I (2-3)4**

Introduction to optical communications, basic theory of light guiding, propagation characteristics and focusing effect of an optical waveguide, optical sources and detectors for fiber communications, fundamental parameters of optical fibers, fabrication and testing methods for optical fibers. Prerequisite: permission of instructor.

80-586 SEMICONDUCTORS **(3-0)3**

Transport and optical properties of semiconductors, statistics, collision mechanisms, and band structure, hot electrons, high magnetic field phenomena. Devices: junctions and transistors, Gunn oscillators, semiconductor lasers. Prerequisite: 95-472 or equivalent.

Physics—Primarily Lecture Courses (Course Prefix: 95)

95-103 GENERAL PHYSICS I **I (3,0)3**

The first semester of a year course which surveys the field of physics for students with majors outside the College of Pure and Applied Science. Topics include force and motion, vectors, gravity, energy and momentum, heat and thermodynamics, and oscillations. Corequisite: 96-103.

95-104 GENERAL PHYSICS II **II (3,0)3**

A continuation of General Physics I. Topics include waves, light, sound, electricity, magnetism, the atom, and the nucleus. Prerequisite: 95-103. Corequisite: 96-104.

95-141 PHYSICS I **I,II (3,0)3**

First semester of a sequence for science and engineering majors. Vectors, kinematics in one and two dimensions, dynamics, work and energy, conservation of energy, center of mass, momentum, conservation of momentum, collisions, statics, rotational kinematics, rotational dynamics and angular momentum. Corequisite: 96-141.

95-142 PHYSICS II FOR COMPUTER SCIENCE **II (3,0)3**
Electric charge, Coulomb's law, electric field, Gauss' law, electric potential, capacitance, D.C. current, Ohm's law, Joule effect, electromotive force, Kirchoff's rules, simple D.C. circuits, magnetic field, current loops, Ampere's law, Faraday's law, electromagnetic waves, A.C. circuits. Prerequisites: 95-141, 92-131. Corequisite: 96-142.

95-144 PHYSICS II **II (4,0)3**
Oscillations, wave motion and wave phenomena. Optics, including reflection, refraction, geometrical optics, interference and diffraction. Thermodynamics, including temperature, heat, heat capacity, ideal gas, first and second laws of thermodynamics. Prerequisites: 95-141, 92-131. Corequisite: 96-144.

95-147 HONORS PHYSICS I **I (4,0)4**
Introductory physics at a more challenging level, commencing with elementary mechanics, fundamental units and dimensions, vector treatment of forces and velocities, statics, equilibrium, kinematics of uniform and accelerated linear motion in one and two dimensions, Newton's laws of motion, friction, relativistic motion and frames of reference, dynamics-impulse, momentum, work, energy and power, conservation and invariance principles, motion of interacting systems, rotational motion-kinematics and dynamics, rotational angular momentum and energy, radial and tangential forces and acceleration, motion of gyroscopes and planets, laws of planetary motion. Corequisite: 96-147.

95-148 HONORS PHYSICS II **II (4,0)4**
Gravitation, elasticity, fluid mechanics, simple harmonic motion, wave motion, temperature and heat, ideal gas behavior, kinetic theory, heat, thermometry and calorimetry, thermal properties of matter, thermodynamics and statistical mechanics, radiation and quantum concepts, applications of quantum theory to quantal systems, atoms, molecules, nuclei and particles. Prerequisites: 95-147 and 92-131. Corequisite: 96-148.

95-151 ELEMENTS OF PHYSICS **II (3,0)3**
An introduction to the topics of physics including: force, work and energy, motion, conservation laws, electricity, magnetism and waves. For industrial technology majors only. Corequisite 96-151.

95-201 PRINCIPLES OF PHYSICS I **(3,0)3**
An introduction to physics for students with majors other than physics in the College of Pure and Applied Science. Topics include Newtonian mechanics in one and two dimensions, harmonic oscillators and waves, calorimetry, heat transfer, and thermodynamics. Corequisites: 96-103, 92-131.

95-202 PRINCIPLES OF PHYSICS II **II (3,0)3**
A continuation of Principles of Physics I. Topics include geometric and physical optics, electricity and magnetism, and atomic and nuclear physics. Prerequisite: 95-201. Corequisites: 96-104, 92-132.

95-209 ELECTRICITY AND MAGNETISM I **I (4,0)4**
Electrostatics: electric charge, Coulomb's law, electric field, Gauss' law, electric potential, capacitance, and dielectrics, electrodynamics, electric current, resistance, Ohm's law, resistivity, electromotive force, D.C. circuits, magnetic field, magnetic dipole moment, Biot-Savart law, Ampere's law, Faraday's law, inductance, and Maxwell's equations. Prerequisite: 95-144 or 95-148.

95-210 INTRODUCTORY MODERN PHYSICS **II (4,0)4**
Special theory of relativity, Galilean transformation, nature and propagation of light, Einstein's postulates and assumptions, Lorentz transformation, simultaneity, time dilation, space contraction, velocity transformation, four vectors, proper time, Newton's second law of

motion, conservation laws, center of mass, and collision problems. The electron: Millikan's experiment, quantum nature of light, the Compton effect and the photoelectric effect, matter waves, Davisson-Germer experiment, wave-particle duality and the uncertainty principle. Prerequisite: 95-209.

95-245 PHYSICS III **I (4,0)3**
Electric charge, Coulomb's law, electric field, Gauss' law, electric potential, capacitance; Ohm's law, Joule effect, electromotive force, Kirchoff's rules, simple D.C. circuits; magnetic field, current loops, Ampere's law, Faraday's law, electromagnetic waves, A.C. circuits, quantum theory; photoelectric effect, de Broglie waves, Bohr atom. Prerequisites: 95-144, 92-132. Corequisite: 96-245.

95-310 ELECTRICITY AND MAGNETISM II **II(4,0)4**
Review of the fundamentals of electricity and magnetism, Maxwell's equations in differential form, plane-wave solutions, polarization, Poynting vector and the flow of energy, radiation pressure, radiation from an accelerated charge, radiation from antennas, Bremstrahlung, cyclotron and synchrotron radiation, blackbody radiation, electromagnetic fields near the surface of a conductor, waveguides, Maxwell's macroscopic equations, propagation of waves in dielectrics, conductors and plasmas, reflection, refraction, scattering, interference and diffraction of electromagnetic waves. Prerequisites: 92-208 and 95-209.

95-335 INTRODUCTORY QUANTUM MECHANICS I **I (3,0)3**
De Broglie waves, the Schroedinger equation, wave functions, wave packets, Heisenberg uncertainty principle, expectation values, particle in a box, the simple harmonic oscillator, free particles, step barrier, barrier penetration, square-well potential, time independent perturbation theory. Prerequisite: 95-210.

95-336 INTRODUCTORY QUANTUM MECHANICS II **II (3,0)3**
The three dimensional Schroedinger equation, the deuteron nucleus, angular momentum, spin, the hydrogen atom, spin-orbit interaction, Zeeman effect, Pauli exclusion principle, atomic structure, multi-electron atoms, the Fermi gas, x-rays. Prerequisite: 95-335.

95-338 PHYSICAL OPTICS **II (3,0)3**
Wave nature of light, mathematics of wave motion, electromagnetic theory of light propagation, reflection and refraction, Fresnel coefficients, polarization, interference, Young's experiment, fringe visibility and coherence, various interferometers, Newton's ring and applications, Fraunhofer diffraction by single and multiple apertures and diffraction gratings. Prerequisite: 95-209.

95-353 ELECTROMAGNETISM I **I (3,0)3**
The theory of electromagnetic fields using vector analysis, electrostatic fields and potentials in vacuum, conductors, and dielectric media, electric multipoles, solutions to Laplace's equation, boundary conditions, image charge problems, magnetic effects of steady currents in nonmagnetic media. Prerequisites: 92-208, 95-210.

95-354 ELECTROMAGNETISM II **II (3,0)3**
Magnetic induction and time varying currents and fields, magnetic materials, Maxwell's equations, propagation of electromagnetic waves in vacuum, conductors and dielectrics, reflection and refraction of electromagetic waves, radiation from accelerating charges and antennas. Prerequisite: 95-353.

95-413 MECHANICS **I (4,0)4**
Coordinate transformations, conservations laws, linear, non-linear and driven oscillators, generalized cordinates, Lagrangian formalism, central forces, non-inertial frames, rigid body motion, and coupled oscillators. Prerequisite: 92-298.

95-421 STATISTICAL THERMODYNAMICS **I (4,0)4**
An integrated study of thermodynamics and statistical mechanics: review of the experimental foundations and historical development of classical thermodynamics, probability and statistical methods of studying macroscopic systems, atomic basis of the laws of thermodynamics and microscopic definitions of thermodynamic quantities using the method of ensembles, entropy and related quantities, TdS equations, Maxwell relations, equation of state, and applications, canonical and grand canonical ensembles, phase transitions; quantum statistics, application to radiation, magnetism, specific heats. Prerequisite: 95-336 or 80-336.

95-461 TOPICS IN NUCLEAR PHYSICS **I (3,0)3**
This course is designed to familiarize the student with a few research areas in the field of nuclear physics. The topics covered may vary from year to year. They will be chosen from the following list: nuclar constituents, fundamentals of interaction forces, liquid drop model and stability energetics, cross sections, passage of ionizing radiations through matter, alpha-decay, beta-decay and electron capture, gamma-decay and internal conversion, nuclear reaction systematics, fission and fusion, models of nuclear structure, and reaction mechanisms. Prerequisites: 95-336.

95-472 TOPICS IN SOLID STATE PHYSICS **II (3,0)3**
Crystal structures, X-ray and neutron diffraction, lattice vibrations, the free electron and the band models of metals, semiconductors and applications, dielectric and optical properties of solids, magnetism and superconductivity. Prerequisite: 95-421.

Primarily for Graduate Students

Graduate courses are open to undergraduates with permission of instructor.

95-505,506 MATHEMATICAL METHODS OF PHYSICS I-II **I (4,0)4; II (4,0)4**
Vector and Cartesian tensor analysis, matrices and determinants, partial differential equations, boundary value problems, and special functions, numerical analysis and applications, theory of analytical functions, Green's functions. Prerequisite: permission of instructor.

95-507 HIGH-ENERGY PHYSICS **I,II (3,0)3**
A survey designed for the nonspecialist. Elements of relativistic scattering theory, the quantum numbers and conservation laws of high-energy physics, strong and weak interactions, dispersion relations. Regge poles and unitary symmetry. Prerequisite: 95-516.

95-511 CLASSICAL MECHANICS **I (3,0)3**
Lagrangian formulation (including Lagrange multipliers), the Kepler problem and Rutherford scattering, rotating coordinate systems and rigid body motion, small oscillations and stability problems, Hamiltonian formulation. Prerequisite: permission of instructor.

95-513 MECHANICS **I (4,0)4**
Coordinate transformations, conservation laws, non-linear, and driven oscillators, generalized coordinates, Lagrangian formalism, central forces, non-inertial frames, rigid body motion, and coupled oscillators. Prerequisite: 92-298.

95-515,516 QUANTUM MECHANICS I-II **I (3,0)3; II (3,0)3**
Wave packets and free particle motion, the wave function and the Schroedinger equation, the linear harmonic oscillator, the WKB approximation, central forces and angular momentum, spin, and time-dependent and independent perturbation theory, scattering theory. Corequisite: 95-511.

95-517,518 ADVANCED QUANTUM MATHEMATICS I-II **I (3,0)3; II (3,0)3**
The formal theory of scattering, Klein-Gordon and Dirac equations and simple applications, quantum theory of radiation, symmetry principles and elements of groups theory, introduction to many-body theory, Hartree-Fock self-consistent calculations and their applications to atomic, solid state, and nuclear physics. Prerequisite: 95-516.

95-521,522 STATISTICAL THERMODYNAMICS **I (4,0)4; II (3,0)3**
Review of classical thermodynamics, probability and statistical methods for macroscopic systems, atomic basis of thermodynamics and microscopic definitions of thermodynamic quantities, entropy and related quantities, TdS equations, Maxwell relations, equations of state, canonical and grand canonical ensembles, phase transitions, quantum statistics, the classical statistical mechanics of Gibbs and Derwin-Fowler, the quantum statistical mechanics of Fermi-Dirac and Bose-Einstein, applications of the theories. Prerequisite: permission of instructor.

95-535 INTRODUCTORY QUANTUM MECHANICS I **I (3,0)3**
De Broglie waves, the Schroedinger equation, wave function, wave packets, Heisenberg uncertainty principle, expectation values, particle in a box, the simple harmonic oscillator, free particles, step barrier, barrier penetration, square well potential. Prerequisite: 95-210.

95-536 INTRODUCTORY QUANTUM MECHANICS II **II (3,0)3**
The three dimensional Schroedinger equation, the deuteron nucleus, angular momentum, spin, the hydrogen atom, spin-orbit interaction, Zeeman effect, Pauli exclusion principle, atomic structure, spectroscopic nomenclature, and molecular structure. Prerequisite: 95-535.

95-553 ELECTROMAGNETISM I **I (3,0)3**
The theory of electromagnetic fields using vector analysis and Maxwell's equations; static electric and magnetic fields in conductors and dielectrics, scalar and vector potentials, solutions to Laplace's equation, image charge problems, and energy density problems. Prerequisite: 92-208, 95-210.

95-554 ELECTROMAGNETISM II **I (3,0)3**
Time-varying electromagnetic fields, ferromagnetic materials, propagation of plane waves in conductors and dielectrics, Snell's law, Fresnel equations, polarization, and radiation from accelerated charges and antennas. Prerequisite: 95-353.

95-557,558 ELECTROMAGNETIC THEORY I-II **I (4,0)4; II (4,0)4**
Electrostatics and magnetostatics with special attention to boundary value problems. Quasistatic fields and displacement currents, Maxwell's equations, the special theory of relativity, waveguides, Mie scattering, radiation from an accelerated charge, plasma physics. Prerequisite: permission of instructor. Corequisite: 95-505/506.

95-560 APPLIED QUANTUM MECHANICS **I,II (3,0)3**
Relativistic Dirac equation of the electron and its simple applications, symmetry principles in quantum mechanics and elements of group theory, introduction to many body theory, Hartree-Fock self-consistent calculations and their applications to the theory of many electron atoms and the nuclei of atoms, emission and absorption of radiation by quantum systems such as atoms and nuclei, widths and intensities of spectral lines, selection rules, electric and magnetic multipole moments of nuclei, and e.m. transition probabilities for nuclei. Prerequisite: 95-515/516.

95-561,562 NUCLEAR PHYSICS I-II **I (3,0)3; II (3,0)3**
Stationary states of nuclei, nuclear charge radius, mass, moments, parity, and statistics, theory of alpha, beta, and gamma decay, fission reactions induced by charged particles, gamma

rays and neutrons, nuclear forces and nuclear models, and fast neutron physics. Prerequisite: permission of instructor.

95-573 ADVANCED THEORY OF SOLIDS I **I (3,0)3**

Lattice vibrations and their interactions with x-rays, neutrons and light, the band model of solids and energy calculations, the Fermi surface, transport and optical properties in metals and semiconductors. Prerequisite: 95-516 and permission of instructor.

95-574 ADVANCED THEORY OF SOLIDS II **II (3,0)3**

Magnetism and magnetic resonance, superconductivity, many body theory and its applications, collective excitations, Green function techniques in solid state physics. Prerequisite: 95-573.

95-575,576 NEUTRAL PARTICLE TRANSPORT I-II **I(3,0)3;II(3,0)3**

Boltzmann and integral trasport equations, spherical harmonic and variational methods, corrections to diffusion theory, special methods of solving transport equations, adjoint functions, applications. Prerequisite: permission of instructor.

95-581,582 THEORY OF NOISE AND RANDOM PROCESSES I-II **I(3,0)3;II(3,0)3**

Probabilities, statistical analysis of random processes, ensemble theory, signals and noise in nonlinear systems, information theory, normally distributed random processes, Langevin, Fokker-Planck and Boltzmann equations, thermal, shot and impulse noise, linear measurements, prediction, and optimum filtering. A strong background in applied mathematics is required. Some knowledge of AC circuit theory and electronics would also be useful. Prerequisite: 95-505,506. 95-521,522 (May be taken concurrently).

95-583,584 GENERAL THEORY OF RELATIVITY I-II **I(3,0)3;II(3,0)3**

Review of Newtonian gravitational theory and special relativity, the weak and strong principles of equivalence, tensor analysis in Riemann spaces, Einstein's equations for the gravitational field, classic tests of Einstein's theory, spherically symmetric solutions, gravitational field theory and the canonical analysis of general relativity. Prerequisite: knowledge of special relativity including tensor notation.

95-601,602 SEMINAR IN PHYSICS **I(1,0)1;II(1,0)1**

95-603,604 SEMINAR IN NUCLEAR PHYSICS **I(1,0)1;II(1,0)1**

95-605,606 SEMINAR IN SOLID STATE OPTICS **I(1,0)1;II(1,0)1**

95-607,608 SEMINAR IN THEORETICAL PHYSICS **I(1,0)1;II(1,0)1**

Individual presentations by students, faculty members, and visiting scientists of advanced topics, original research, or journal articles.

95-611,612 GRADUATE SEMINAR IN PHYSICS **I(1,0)1;II(1,0)1**

Presentations by students of research in progress.

95-651,652 SELECTED TOPICS IN PHYSICS **I(3,0)3;II(3,0)3**

95-653,654 SELECTED TOPICS IN NUCLEAR PHYSICS **I(3,0)3;II(3,0)3**

95-655,656 SELECTED TOPICS IN SOLID STATE OPTICS **I(3,0)3;II(3,0)3**

95-657,658 SELECTED TOPICS IN THEORETICAL PHYSICS **I(3,0)3;II(3,0)3**

Recent advances and more advanced topics not covered in the regular courses in these areas. Subject matter varies, depending on the interests of the instructor and the needs of the students. Subject matter varies sufficiently that these courses may be taken more than once for credit without repeating topics.

95-751,752 ADVANCED PROJECTS IN PHYSICS **I(3,0)3;II(3,0)3**
Independent reading or research not for thesis. Prerequisite: permission of instructor.

Primarily Laboratory Courses (Course Prefix: 96)

96-103 GENERAL EXPERIMENTAL PHYSICS I **I (1,2)1**
The first semester of a year course which surveys the field of experimental physics with topics correlated with 95-103 and 95-201. Corequisite: 95-103 or 95-201.

96-104 GENERAL EXPERIMENTAL PHYSICS II **II (2,1)1**
A continuation of General Experimental Physics I with topics correlated with 95-104 and 95-202. Prerequisite: 96-103. Corequisite: 95-104 or 95-202.

96-141 BASIC EXPERIMENTS IN PHYSICS FOR 95-141 **I, II (.5,1)1**
A set of experiments designed to manifest the principles and concepts of the corequisite lecture course 95-141. Corequisite: 95-141.

96-142 BASIC EXPERIMENTS IN PHYSICS FOR 95-142 **II(.5,1)1**
A set of experiments designed to manifest the principles and concepts of the corequisite lecture course 95-142. Prerequisites: 95-141 and 96-141. Corequisite: 95-142.

96-144 BASIC EXPERIMENTS IN PHYSICS FOR 95-144 **II (.5,1)1**
A set of experiments designed to manifest the principles and concepts of the corequisite lecture course 95-144. Prerequisites: 95-141 and 96-141. Corequisite: 95-144.

96-147 FUNDAMENTALS OF EXPERIMENTAL PHYSICS I HONORS **I (1,3)2**
An introductory course at the honors level on the methods and techniques of experimental physics. Lectures on measurement uncertainties and error analysis are included and experiments are selected principally in the areas of statics and kinematics. Corequisite: 95-147.

96-148 FUNDAMENTALS OF EXPERIMENTAL PHYSICS II HONORS **II (1,3)2**
A continuation of 96-147 with experiments selected principally from mechanics, waves, optics and thermodynamics. Students are introduced to more advanced measurement techniques and instrumentation than in 96-144. Prerequisite: 96-147. Corequisite: 95-148.

96-151 ELEMENTS OF EXPERIMENTAL PHYSICS **II (3,0)1**
This course is for Industrial Technology majors and introduces the student to basic experimental techniques in physics with applications principally in the areas of mechanics and electricity. Corequisite: 95-151.

96-245 BASIC EXPERIMENTS IN PHYSICS FOR 95-245 **I (.5,1)1**
A set of experiments designed to manifest the principles and concepts of the corequisite lecture course 95-245. Prerequisites: 95-144 and 96-144. Corequisite 95-245.

96-258 PHYSICAL INSTRUMENTATION I **II (1,3)2**
Introduction to measuring devices emphasizing practical physical applications. Topics covered will include both analog and digital techniques, fundamentals of transistors, diodes, integrated circuits, operational amplifiers, filters, digital circuits, logic elements and the basics of a microprocessor.

96-293 EXPERIMENTAL PHYSICS I **I (1,6)3**
A course in experimental physics, with related theoretical material. Experiments are principally in the area of electrical measurements. Lectures are given on laboratory techniques and practices, and on the elementary theory of errors. The laboratory and lectures are integrated. Prerequisite: 95-144 or 95-148.

96-294 EXPERIMENTAL PHYSICS II **II (1,6)3**
Continuation of 96-293. Experiments are principally in the areas of optics, thermodynamics, mechanics and atomic and nuclear physics.

96-338 PHYSICAL OPTICS LABORATORY **II (0,6)2**
Experiments in physical optics covering the following topics; Michelson and Twyman-Green interferometers, Newton's rings, optical testing, multiple beam interference, diffraction grating, spectroscopy, Fresnel and Fraunhofer diffraction, reflection of light from a dielectric surface, polarization, holography. Prerequisite: 96-337. Corequisite: 80-338 or permission of the instructor.

96-359 PHYSICAL INSTRUMENTATION II **I (1,3)2**
Study of standard laboratory measuring instruments, signal processing, interfacing of computers with laboratory instrumentation, parallel and series, analog-to-digital and digital-to-analog conversion, and input/output ports as device controllers. Prerequisite: 96-258.

96-393 INTERMEDIATE PHYSICS LABORATORY I **I (0,6)2**
Advanced experiments in various branches of physics including optics and atomic physics. Prerequisite: 96-294.

96-394 INTERMEDIATE PHYSICS LABORATORY II **II (0,6)2**
Advanced experiments in various branches of physics including solid state physics and nuclear physics, with opportunities for independent work by permission of the instructor.

96-495 SPECIAL RESEARCH PROBLEMS I **I (3,0)3**
Special problems in physics assigned to the individual student with emphasis on modern research methods and preparation of results for publication. Prerequisite: permission of department chairperson and instructor.

96-496 SPECIAL RESEARCH PROBLEMS II **II (3,0)3**
A continuation of 95-495 for a second semester. Prerequisite: permission of department chairperson and instructor.

Primarily for Graduate Students

Graduate courses are open to undergraduates with the permission of the instructor.

96-509 PHYSICS PRACTICUM I **I (1,1)1**
Through observation, the presentation of demonstrations and experiments, the student becomes familiar with instructional techniques in experimental physics. Prerequisite: permission of the instructor.

96-510 PHYSICS PRACTICUM II **II (1,1)1**
A continuation of 96-509.

96-701,702 GRADUATE RESEARCH IN PHYSICS **I(0,9)3;II(0,9)3**
Research for M.S. or Ph.D. Thesis or M.S. project. Prerequisite: department approval of research proposal.

96-711,712 SPECIAL PROBLEMS IN PHYSICS **I(0,9)3;II(0,9)3**
Reading in preparation for research (in subjects not offered in courses at the time the student wishes to study them), or research not for thesis. If results of the research are subsequently incorporated in a thesis, credits earned in this course may be used to satisfy credit requirements in 95-701,702, Graduate Research. If results are incorporated in an M.S. project, not more than 3 credits are allowed. Prerequisite: permission of instructor.

Radiological Health Physics (Course Prefix: 98)

98-101 INTRODUCTION TO RADIOLOGICAL SCIENCES I **I(3,0)3**
Introduction to atomic and nuclear physics, natural and artificial radioactivity, radiation, decay schemes, nuclear reactions including fission and fusion, interaction of radiation with matter, radiation quantities and units, shielding, biological effects of radiation, radiation protection standards and regulations.

98-102 INTRODUCTION TO RADIOLOGICAL SCIENCES II **II(3,0)3**
Principles of radiation detection and detection devices, counting systems and assay of alpha, beta, and gamma emitters, survey and monitoring equipment, external radiation exposure and protection techniques, radiation safety and control, accelerator and reactor health physics, medical radiation physics and X-ray protection.

98-201 HEALTH PHYSICS INTERNSHIP I **I (0,10)3**
Applied work experience as a health physics technician at a government laboratory or a radiation facility of some industry, hospital, or education and research institution. Prerequisites: Radiological Health Physics major; 98-101 and 98-102; approval department chairperson.

98-202 HEALTH PHYSICS INTERNSHIP II **II (0,10)3**
Applied work experience as a health physics technician at a government laboratory or a radiation facility of some industry, hospital, or education and research institution. Prerequisite: Radiological Health Physics majors; 98-102; approval department chairperson.

98-301 HEALTH PHYSICS INTERNSHIP III **I (0,10)3**
Applied work experience as a health physics technician at a government laboratory or a radiation facility of some industry, hospital or education and research institution. Students in this course will be given increased responsibilities commensurate with prior experience. Prerequisites: Radiological Health Physics major; 98-101 and 98-102, approval department chairperson.

98-302 HEALTH PHYSICS INTERNSHIP IV **II (0,10)3**
Applied work experience as a health physics technician at a government laboratory or a radiation facility of some industry, hospital, or educational and research institution. Students in this course will be given increased responsibilities commensurate with prior experience. Prerequisites: Radiological Health Physics major; 98-102; approval department chairperson.

98-336 INTRODUCTION TO HEALTH PHYSICS **II (3,0)3**
A course for student with a major other than Radiological Health Physics. Topics include radioactivity, interaction of radiation with matter, biological effects of radiation, external and internal radiation dosimetry, radiation shielding, radiation standards and regulations, health physics instrumentation, practices and principles of radiation protection. Prerequisite: 80-355.

98-356 PHYSICS OF RADIATION AND NUCLEI **II (3,0)3**
Subject matter will be selected on the basis of its fundamental usefulness in radiological health physics. Material covered in Physics of Radiation and Nuclei I will be re-examined and studied in greater depth. Other topics such as neutron physics, nuclear fission and fusion, nuclear models and forces, accelerator physics, lasers, theory of solids, solid state devices and detectors, and energy deposition by mechanical and electromagnetic radiation will be covered when time and interest permit. Prerequisite: 80-355.

98-401 PRINCIPLES OF RADIATION SAFETY AND CONTROL I **I (3,3)4**
Introduction to radiation protection, including radiation sources, radiation dose and dose

measurement, radiation exposure, radiation protection techniques, monitoring methods and instruments, contamination control and waste storage, facility design, hazards analysis, and applied health physics techniques for the safe handling and control of radioactive material including laboratory. Prerequisite: 80-202 or equivalent.

98-402 PRINCIPLES OF RADIATION SAFETY AND CONTROL II II (3,3)4
A laboratory course giving students experience with equipment and practices of current use in the radiation protection field, and extension of 98-401 giving some of the practical aspects of radiation safety and control. Prerequisite: 98-401.

98-411/412 RESEARCH IN RADIOLOGICAL SCIENCES I,II (0,10)3
A research problem related to the field of radiation protection is investigated by the student under the direction of faculty and staff of the Nuclear Center. The student will present a seminar on his research project. Areas of research anticipated include radiation shielding, radiation detection and measurement, radiation survey and monitoring, radiation biology, radiation chemistry, radiobiology, radiochemistry, radioecology, natural radioactivity, fall out, analyses and measurement of radioactivity and radiation levels associated with the operation of reactors and accelerators, and radioactive aerosols. Prerequisites: senior status as radiological health physics major and approved proposal.

98-422 ENVIRONMENTAL RADIATION AND NUCLEAR SITE CRITERIA II (3,0)3
Sources of radioactive waste and waste treatment, internal dosimetry, maximum permissible concentrations, distribution of radioactivity in the environment and the significance of releases to the air, aquatic and terrestrial ecosystems, design and operation of environmental surveillance programs around nuclear facilities, reactor site criteria, licensing, regulations, credible accidents, meteorological considerations, normal and abnormal operations, environmental impact of nuclear reactors. Prerequisite: 98-401 or equivalent.

98-441 RADIOISOTOPE TECHNIQUES I (3,0)3
A course for students and staff designed to acquaint them with the theory and use of radioisotopes and the principles and operation of radiation counting systems. Lecture sessions are topics related to biological effects of radiation exposure, safe use of radiation sources, radiation protection techniques and procedures, and design of radiation facilities. Prerequisite: senior status as Biology major or equivalent background.

98-443 RADIOISOTOPE TECHNIQUES LABORATORY I (0,3)1
Laboratory experience in tracer techniques and appropriate use of various types of laboratory counting instruments. Corequisite: 99-141 or equivalent.

98-451 INTRODUCTION TO ELECTRONIC PRODUCT RADIATION I (3,0)3
The theoretical and applied aspects of the generation, measurement, and uses of radiant energy from electronic products whose emissions span the entire electromagnetic spectrum; ultrasonic energy emitted by electronic products; biological effects, standards of protection and control, and consequences and intent of Public Law 90-602. Prerequisite: 98-401.

98-461 SPECIAL TOPICS IN RADIOLOGICAL SCIENCES I I (3,0)3
This course is used to provide students with current information on a variety of current topics. Topics covered are announced prior to registration. Topics may vary from year to year. Prerequisite: senior status as Radiological Health Physics major.

98-462 SPECIAL TOPICS IN RADIOLOGICAL SCIENCES II II (3,0)3
This course is used to provide students with current information on a variety of current topics. Topics covered are announced prior to registration and may vary from year to year. Prerequisite: senior status as Radiological Health Physics major.

98-472 RADIATION BIOLOGY **II (3,0)3**
A study of the interactions of radiation with living systems. The effects of ionizing radiation on the molecular, cellular and organismic levels. The acute and latent effects in whole animals and the modification of radiation exposure by physical, chemical and biological factors. Prerequisites: 81-252, 98-441 or equivalent.

98-481 MATHEMATICAL METHODS OF RADIOLOGICAL SCIENCES **I (3,0)3**
A course for those majoring in Radiological Sciences and Protection. An applied course emphasizing the mathematical skills used in radiological sciences/health physics fields, including special techniques used in radiation physics, radiation dosimetry, and radiation shielding. Microcomputer applications including numerical techniques will be included. Prerequisite: permission of instructor.

Primarily for Graduate Students

Graduate courses are open to undergraduates with permission of the instructor.

98-505 RADIATION DOSIMETRY **I(3-0)3**
Sources of radiation exposure; calculations of chronic and acute radiation doses and their effects; internal dosimetry including distribution and elimination of radioisotopes, alpha, beta, gamma, and neutron dosimetry, principles of charge measurement and energy transfer, use and calibration of instruments including solid state dosimeters, ion chambers, and extrapolation chambers.

98-507 RADIATION DOSIMETRY LABORATORY **I(0,3)1**
Laboratory experience coordinated with lecture sequence in 98-505. Corequisite: 98-505.

98-508 ENVIRONMENTAL TOXICOLOGY AND EPIDEMIOLOGY **I(3,0)3**
Study of toxicology and epimemiology of physical and chemical agents including: air pollutants, food additives, ionizing and non-ionizing radiations. Review of current health standards. Prerequisite: Graduate student with science background.

98-510 ENVIRONMENTAL TOXICOLOGY LABORATORY **I(0-3)1**
Laboratory studies of the effects of toxic agents on plant and animal systems with emphasis on radiation and air pollution. Corequisite: 95-508.

98-513 ENVIRONMENTAL MONITORING AND SURVEILLANCE **I(3-0)3**
Sources and types of natural and man-made environmental radioactivity, objectives and design of monitoring programs with emphasis on sampling and analytical measurement programs for specific radionuclides and external radiation sources, analytical equipment and procedures and limits of detection for specific radionuclides, design of an experimental laboratory and quality assurance programs for nuclear power stations. Prerequisite: 98-502.

98-514 EXTERNAL RADIATION DOSIMETRY **II(3-3)4**
Radiation quantities and units: beta, gamma, and neutron dosimetry, principles of charge measurement and energy transfer, use and calibration of instruments calibration sources, accident dosimetry, standards and regulatory requirements. Prerequisite: 98-501/502.

98-515 DATA REDUCTION FOR RADIOLOGICAL SCIENCES AND PROTECTION **II(3-0)3**
Fundamental statistical concepts of errors, means, variance and standard deviatons of parent anad sample populations; permutations and combinations; integral, discrete and differential distribution functions; samplings and counting experiments; propagation of errors; minimum detectable activity and lower limit of detection of counting systems; chi square and other statistical tests of the operability of counting systems; tests of distributions and fitting functions. Prerequisite: Permission of instructor.

98-516 INTERNAL RADIATION DOSIMETRY **I(3-0)3**
Physiological models for standard man; metabolic models and kinetics; 1959 ICRP 2 and the 1978 ICRP 30 publications; standards and regulatory requirements.

98-525 MEDICAL HEALTH PHYSICS **II(3-0)3**
Sources of radiation and radioactive material associated with the medical applications of nuclear medicine, x-ray diagnosis, and radiation therapy, shielding of x-ray and radiation therapy facilities, survey and monitoring instruments and procedures, personal monitoring, federal and state regulations, waste disposal, and clinical support role of health physicist. Prerequisite: 98-501 and 81-252 or equivalent.

98-532 INTRODUCTION TO NUCLEAR RADIATION SHIELDING **II(3-0)3**
Interaction of neutrons, gamma rays, and charged particles with matter, buildup factors, shielding of point, surface, and volume sources, shielding design factors in reactor and accelerator operation. Prerequisite: Permission of instructor, Advanced Calculus, and Radiological Sciences Graduate Student or equivalent.

98-534 INTRODUCTION TO RADIATION SHIELDING LABORATORY **II(0-3)1**
Laboratory coordinated with 98-352 with applications to health physics problems. Corequisite: 98-352. (Not offered every year.)

98-545 ACCELERATOR HEALTH PHYSICS **I(3-0)3**
Health physics problems common to particle accelerator facilities are presented with discussions of current approaches to their solutions. Estimation of the levels of induced radioactivity expected and calculations of shielding and ventilation requirements will be made for a variety of particle accelerators. Prerequisite: 98-501/502.

Radiological Health Physics

Courses for Non-Majors (Course Prefix: 99)

99-101,102 RADIATION AND LIFE **I,II(3,0)3**
An introduction to the field of radiological sciences, including discussions of benefits and risks of nuclear energy. Lectures, demonstrations and field trips. Recommended for non-science majors. May not be credited to Radiological Health Physics majors.

99-461,462 SPECIAL TOPICS IN RADIOLOGICAL SCIENCES **I,II(1-3,0)1-3**
This course is used to provide non-major students with current information on a variety of topics in radiological sciences. Topics covered are announced prior to registration. May not be credited to Radiological Health Physics major.

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Curtis P. Hinckley, Associate Professor, Biological Sciences; B.A., Yale University; Ed.M., Harvard University

Jerome L. Hojnacki, Professor, Biological Sciences; B.S., Southern Connecticut State College; M.S., University of Bridgeport; Ph.D., University of New Hampshire; M.H.A., Clark University

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Martin Isaks, Associate Professor, Chemistry; B.S., Purdue University; M.S., Iowa State University; Ph.D., University of Cincinnati

Stanley C. Israel, Professor, Chemistry; B.S., Parsons College; Ph.D., Lowell Technological Institute

Edwin Jahngen, Jr., Associate Professor, Chemistry; B.S., Bates College; Ph.D., University of Vermont

Barbara L. Jensen, Associate Professor, Physics; B.S., University of Utah; M.A., Ph.D., Columbia University

Lee K. Jones, Professor, Mathematics; B.S., Tufts University; M.S., Ph.D., Stanford University

Gerald Kaiser, Associate Professor, Mathematics; B.S., Case Institute of Technology; M.S., Ph.D., University of Wisconsin; Ph.D., University of Toronto

Ethel N. Kamien, Professor, Biological Sciences; B.A., Brooklyn College; M.S., Ph.D., University of Wisconsin

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Judith A. Kelley, Associate Professor, Chemistry; B.A., Emmanuel College; M.S., Lowell Technological Institute; M.Ed, Ed.D, Northeastern University

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Jerry Waldman, Professor, Physics; B.A., M.A., Columbia University; Ph.D., Massachusetts Institute of Technology

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I. Jacob Weinberg, Professor, Mathematics; B.S., Yeshiva University; M.S., Ph.D., Massachusetts Institute of Technology

Peter Weston, Instructor, Computer Science; B.A., University of Maryland; M.A., University of Lowell

Joyce W. Williams, Associate Professor, Mathematics; B.A., University of Minnesota; M.S., Ph.D., University of Illinois

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Richard E. Winslow, Assistant Professor, Mathematics; B.A., Columbia University; M.A., Ph.D., Brandeis University

Edwin Wolf, Assistant Professor, Mathematics; B.A., Amherst College; M.A., Ph.D., Brown University

Chuen Wong, Associate Professor, Physics; Dip. Sci. Chung Chi College (Hong Kong); Ph.D., Case Institute of Technology

Lee-Jun Wong, Associate Professor; Biological Sciences; B.S., National Taiwan University; Ph.D., Ohio State University

Shan S. Wong, Professor, Chemistry; B.S., Oregon State University; Ph.D., Ohio State University

COLLEGE OF EDUCATION

M. Virginia Biggy, Dean

Professors: Norman F. Benson, M. Virginia Biggy, Thomas G. Devine, Richard G. Lyons, Mary E. McGauvran, *Emerita,* Donald E. Pierson, Margaret R. Shannon, *Emerita.*

Associate Professors: John J. Catallozzi, Penelope Z. Demogenes, *Emerita,* Robert R. Gower, Brenda L. Jochums, Alice G. Kiernan, *Emerita,* Anne M. McParland, Dorothy V. Meyer, Susan Neuman, William T. Phelan, Nancy Weiner.

Assistant Professors: Douglas H. Adamson, James E. Carifio, Gail M. Carney, Lorraine D'Agostino.

The preparation of graduates for professional careers in education has been a responsibility of the University of Lowell and its predecessor institution, Lowell State College, since 1894. Graduates of degree programs in education have rendered service as teachers, specialists, and administrators in the schools, colleges and universities, and public and private enterprises of the Commonwealth and the nation. The College of Education continues an historic commitment to education through its graduate degree programs and is committed to maintaining and continuously improving quality programs in education which will produce the high caliber personnel which the schools of the future will require. For information concerning degree programs in education, see the Graduate School Bulletin.

OBJECTIVES OF THE COLLEGE OF EDUCATION

Through degree programs which prepare intellectually able, liberally educated, and professionally competent teachers and other educational and administrative personnel for leadership roles in school and non-school settings, the faculty of the College of Education seek to improve instruction for students in the public and independent schools in the Commonwealth and the nation and to address, especially, the issues of equity and excellence.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Education is organized into three centers and is administered by a dean who is assisted by an advisory council. The three centers are responsible for developing course offerings and programs of studies. Although the faculty of the College has overall responsibility for all academic policies of the College, the Academic Standards and Admissions Committee is responsible for developing and enforcing decisions on all candidates applying for admission to the College of Education, and for reviewing the appeals of students who fail to meet the requirements for admission to or retention in degree programs.

Dean's Advisory Council

Dr. Norman F. Benson, Professor of Education
Dr. John J. Catallozzi, Coordinator, Center for the Study of Curriculum and Instruction
Dr. Gail M. Carney, Coordinator, Office of Field Experiences and Certification
Dr. Anne M. McParland, Coordinator, Center for Reading and Language
Dr. Dorothy V. Meyer, Coordinator, Center for Administration, Planning and Policy, Chair of the Faculty
Student to be elected

GRADUATE PROGRAM IN ELEMENTARY EDUCATION

The College of Education offers a graduate program in elementary education which leads to the degree of Master of Education (Ed. M). This degree program is designed to prepare students for professional certification as teachers of grades one through six in the elementary schools.

The requirements of admission to this full-time graduate degree program include the following:

> An earned Bachelor of Arts or Bachelor of Science degree with an academic major of 36 semester hours.
>
> Satisfactory completion of undergraduate courses in the elementary education fields of knowledge such as American literature, American history, American politics, psychology, art, pre-calculus mathematics, theory of computer programming, life science, life and health, and physical education.

The above courses may be taken as part of the undergraduate University core requirements, academic major, or unrestricted electives.

Other requirements for admission to the graduate degree program include the four-year cumulative grade-point average, evidence of effective communication skills in English, cumulative grade-point average in the academic major, and performance on the Graduate Record Examination, or the Miller Analogies Test. Detailed information on these requirements may be obtained from the College of Education.

GRADUATE PROGRAM IN SECONDARY EDUCATION

The College of Education does not offer undergraduate degree programs.

The graduate degree programs in elementary education and secondary education are designed to prepare students for professional certification as teachers. These degree programs are unique in that they require students to have completed liberal arts, mathematics, or science majors at this or other universities. Students who contemplate a teaching career upon completion of the baccalaureate degree should talk with Dr. Gail M. Carney in the college for help with field experiences and information about matriculation.

This degree program in teacher education is designed for those who plan to teach in a secondary school and to achieve teacher certification in Secondary Education. Successful completion of the program leads to an Ed. M. degree. A requirement for admission to the program is an earned baccalaureate degree with a 36-hour major in liberal arts, mathematics or science. Students should obtain information from the College of Education.

Students may be prepared to teach in art, English, history, social studies, biology, chemistry, earth science, physics, mathematics, French, Spanish, and behavioral sciences. All students must meet the secondary education field of knowledge requirements as mandated by the Commonwealth of Massachusetts.

Foundations of Education (Course Prefix: 01)

01-302 SOCIAL PSYCHOLOGY AND EDUCATION (3,0)3
A study of the major concepts presently used to explain, predict, and modify social interaction, motivation, attitudes, group behavior and leadership. The experiments conducted by Festinger, Rokeach, Milgram and Asch will be examined and utilized as a means of analyzing such classroom problems as poor behavior and attitudes, lack of motivation, and ineffective peer relationships. Catallozzi.

01-322 EDUCATION AND CONTEMPORARY SOCIETY (3,0)3
Deals with social and cultural pressures on the educational system. Among the topics discussed are norms of authority, pupil decision making, the influences of peer groups and education and contemporary life styles. Lyons.

01-323 MORAL PROBLEMS IN MEDICINE (3,0)3
This course will emphasize those arguments which are used to justify moral decisions which confront medicine specifically and the public generally. The problems of drugs and personality alteration, artificial insemination, euthanasia, sterilization, truth and the patient, contraception, poverty and medical care, abortion, genetic engineering, and organ transplants will be discussed as they relate to the problems of human values and moral obligation. Lyons.

01-341 THE MEASUREMENT OF INTELLIGENCE (3,0)3
This course traces the development of intelligence testing, considering topics such as the value of intelligence testing in terms of diagnosis, description, and predication, the heredity-environment controversy, and the correct use and interpretation of test results. Appropriate measurement and statistical background are provided where necessary. Catallozzi.

01-351 THE PUBLIC SCHOOLS (3,0)3
A course for the consumers-those who will be parents, taxpayers, school board or other public office holders. It will provide background on the responsibilities of school board members, the laws which have direct effect on schools, the organization of public schools, the curriculum and special services, fiscal concerns and the nationwide interest in assessment and accountability. Observation in elementary and secondary schools and at School Board and Finance Committee meetings will be required. Staff.

01-361 MEASUREMENT AND EVALUATION (3,0)3
This course introduces the prospective teacher to the principles and procedures of measurement and evaluation that are essential to excellence in teaching. The main theme throughout is that evaluation is an integral part of instructional design and it involves: (1) the major categories of learning outcomes, (2) constructing teacher-made assessments relevant to the outcomes of learning, (3) using the assessments for feedback to improve tasks of learning and instruction. Material will be added on criterion-referenced assessment and defining and writing performance objectives for evaluation purposes. The teacher will be able to select published tests with an understanding of the concepts of validity and reliability and, in addition, will be able to use standardized tests and interpret test scores. Practices or learning experiences will be presented to the student in areas requiring specific skills in measurement and evaluation. Washbon.

01-371 EDUCATIONAL PSYCHOLOGY II(3,0)3
Designed as an introduction to the study of human learning, this course covers such topics as efficiency in learning, testing, the psychology of teaching, and theories of human learning. Catallozzi.

01-373 TEACHING AND LEARNING STRATEGIES (3,0)3
An introduction to the study of human learning, this course covers such topics as efficiency in learning, the psychology of teaching, and theories of human learning. Physical Therapy majors only. Catallozzi.

01-381 SOCIOLOGY OF EDUCATION (3,0)3
The educational system is analyzed as an institution whose organizations and purposes reflect the socialization needs of the wider society. The school is studied as a social system and problems of authority, the role of the teacher, peer groups, aspirations and mobility of clientele are considered. Reciprocal relations of school and community are examined with reference to such factors as social class, family and occupational systems. Special emphasis is placed on the issue of equality of educational opportunity and on recent organizational changes which attempt to meet this goal. Opportunities for field work are included as an integral part of the course. Phelan.

01-382 SOCIAL ORGANIZATION OF SCHOOLS AND SCHOOL SYSTEMS (3,0)3
Problems of authority, coordination, and innovation in schools are examined from the perspective of different social factors in a school system. The role demands and expectations of teachers, pupils, principals, superintendents, and members of a board of education are assessed. The school is treated both as a bureaucratic organization and as a social setting for the informal interaction of personnel. Questions and issues dealing with innovative forms of organization such as the open-classroom are analyzed and evaluated. Phelan.

01-384 EDUCATION AND CULTURAL DIVERSITY (3,0)3
This course is designed to familiarize students with the cultural richness of a multi-ethnic, multi-racial society. Course readings, class discussions and written work are intended to help the future teacher: (1) to isolate opinions and prejudices about the values, norms, and life styles of people having different ethnic, racial, and social class backgrounds, and (2) to avoid and discourage racial, sexual, ethnic, religious, physical and other stereotyping, and (3) be aware of and correct any ethnic, racial or sexual bias. Fulfillment of these objectives will contribute to a future teacher's responsiveness to the individual needs of students so as to enhance their self-esteem. Also, a teacher will be able to develop a learning environment favorable to open inquiry and devoid of riducule. Phelan.

01-391 PHILOSOPHY OF EDUCATION I,II(3,0)3
This course will emphasize the philosophical dimensions of education with special emphasis given to the goals of education, the notion of the person in social context and the structure of knowing. Lyons.

01-560 INTRODUCTION TO TEACHING (3,0)3
This course examines briefly the history of teaching in our society, traditions, myths, and folklore associated with various kinds of teaching, and the importance of teaching for the continuation of a literate society. Staff.

FACULTY OF THE COLLEGE OF EDUCATION

OFFICE OF THE DEAN

M. Virginia Biggy, B.S., Ed.M., Ed.D., Dean

CHAIRPERSON OF THE FACULTY

Dorothy V. Meyer, A.B., Ed. M., Ed.D.

COORDINATORS OF CENTERS

Anne M. McParland, B.S., Ed.M., C.A.G.S., Ed.D., Center for Reading and Language
John J. Catallozzi, B.S., Ed.M., Ed.D., Center for the Study of Curriculum and Instruction
Dorothy V. Meyer, A.B., Ed.M., Ed.D., Center for Administration, Planning and Policy

RESIDENT FACULTY

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Anne M. McParland, Associate Professor; B.S., University of Lowell; C.A.S., Harvard University; Ed.M., Ed.D., Boston University.

Dorothy V. Meyer, Associate Professor; A.B., Houghton College; Ed.M., Ed.D., Boston University.

Susan Neuman, Associate Professor; B.A., American University; M.A., California State University; Ed.D., University of the Pacifics.

William T. Phelan, Associate Professor; A.B., Boston College; A.M., Catholic University; Ph.D., University of Chicago.

Donald E. Pierson, Professor; Director, Center for Field Services and Studies; A.B., Princeton; Ed.M., Ph.D., Harvard University.

Margaret R. Shannon, Dean and Professor *Emerita*; B.S., University of Lowell; Ed.M., Ed.D., Harvard University.

Nancy Wyner, Assistant Professor; A.B., Boston University; M.A., Ed.D., Columbia University; J.D., Northeastern University.

COLLEGE OF ENGINEERING

Aldo Crugnola, Dean
Louis J. Petrovic, Assistant Dean

S. J. Chen, Assistant to the Dean for Graduate Studies
John C. O'Callahan, Director, Computer Aided Engineering and Design Center
James Phelps, Assistant to the Dean for Baccalaureate Options
Kenneth L. Rogers, Assistant to the Dean for Facilities

Engineering is a profession which is concerned with the application of scientific knowledge to society. It is involved in the identification of societal needs, the definition of technological problems which address these needs, and the construction of creative solutions to these problems.

The College of Engineering recognizes that the engineering needs of society are complex and varied, as are the diverse interests, motivations, competencies, and backgrounds of its students. Therefore, it has developed a broad spectrum of programs to serve both the needs of students and the high technology sector of the Massachusetts economy. The emphasis within each engineering program is on technical rigor, utilizing the latest advances in computer technology for the solution of engineering problems. At the same time, each program is characterized by a curriculum that is broad enough to produce engineers who are qualified to meet contemporary demands.

The College has 18 active chapters of professional engineering societies, including the National Society of Black Engineers and the Society of Women Engineers. In addition, it has a chapter of Tau Beta Pi, the national engineering honor society. Participation of students in these societies is encouraged.

A review course is offered in cooperation with the Massachusetts Society of Professional Engineers for students planning to take the Engineer-in-Training (E.I.T.) examination. The college serves twice a year as host for the examination which is a requirement for registration as a professional engineer. Students are strongly urged to take the E.I.T. examination at the appropriate time.

OBJECTIVES OF THE COLLEGE OF ENGINEERING

The College of Engineering seeks to prepare men and women for entrance into the engineering profession in anticipation of their becoming leaders in industry, government, and education. Programs in the College of Engineering have been structured to permit students the option of entering the practice of engineering immediately after attaining an undergraduate degree or to delay entrance until they have attained a graduate degree.

Programs are available in several engineering disciplines to accommodate varied interests. In addition, within each discipline students may prepare for careers such as research, development, design, production, construction, teaching, and management. A faculty advisor is assigned to each student to provide experienced guidance in selecting programs and courses and in career planning.

Each student is encouraged to develop his or her full potential as an engineer, with a high degree of awareness of the technological needs of society, the nation, and particularly those of Massachusetts industry, government, and educational institutions.

The college stresses professional needs by continuously updating courses and options in the standard engineering and selected specialty programs. The departments use all available resources to advance the level of excellence of their programs. Standards are monitored by the Engineering Accreditation Commission and the Technology Accreditaiton Commission of the Accreditation Board of Engineering and Technology (ABET) and the National Association of Industrial Technology (NAIT). Departments adhere to the standards of the National Society of Professional Engineers. The college also follows the careers of successful graduates, and solicits their views on making programs more relevant and effective.

In each discipline the College of Engineering offers graduate research programs which not only serve as a source of updating the undergraduate course offerings, but also ensure that faculty are on the cutting edge of their particular disciplines. These programs advance the general level of information and knowledge that is so essential in fast-moving technological fields, while providing the highly specialized research required by industry. By functioning as an educational resource to the engineering profession and industry of the Commonwealth through instruction, consulting services, and research, the College of Engineering at the University of Lowell provides its students with an ever-current view of the working world for which they must prepare.

The college offers a continuing education program in the evening leading to associate and baccalaureate degrees in engineering technology. Continuing education provides men and women an opportunity at the associate, undergraduate, and graduate degree levels to further their preparation for careers.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Engineering is organized into six departments and is administered by a dean. As the chief academic and executive officer, it is the dean's responsibility to formulate goals and objectives for the college within the context of the University mission and to implement programs of high academic quality to attain these goals. The dean is supported by an assistant dean who is responsible for academic and external affairs and four faculty members who coordinate graduate studies, facilities, planning, computer-aided engineering and design, and the humanities and social studies component of the engineering programs. The academic standards committee of the college and the industrial advisory council in each of the professional areas support the college and the departments in monitoring academic standards and in developing state-of-the-art professional curricula.

The six departments of the college are Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Technology, Mechanical and Energy Engineering, and Plastics Engineering. While focusing on their respective special fields of study, the departments share many common interests in engineering, science, the humanities, and social sciences. Though students must declare a major in a specific department, they take courses in several departments both within and outside of the college.

Each department is administered by a department head. Each is responsible for developing its own course offerings and programs of study. The engineering faculty as a whole is responsible for all academic policies of the college.

Academic Standards Committee

The academic standards committee, composed of faculty, usually department heads representing each department, is responsible for enforcing academic standards of the college and establishing and enforcing disciplinary procedures. This committee also serves as a review body for suspended students seeking readmission to the college.

Members of the committee are:

Roger H. Baumann, Chairperson
Aldo M. Crugnola, Dean
Donald Pottle, Industrial Technology
Karl Sladek, Chemical Engineering
Richard Madden, Mechanical Engineering
Donald Leitch, Civil Engineering
Sidney A. Bowhill, Electrical Engineering
Nick R. Schott, Plastics Engineering

Industrial Advisory Councils

Several advisory councils composed of industry leaders support the college and departments in formulating new curricula and in keeping programs up-to-date with rapidly advancing high technology. These councils serve to promote a high degree of interaction between the college and the Commonwealth industry which it serves.

College of Engineering

John Connolly, Vice President, Tau-Tron, Inc.
Walter Flinn, Western Electric.
Paul Hoffman, President, Avco Corporation.
John C. Lavallee, Vice President, Century Banks
Ralph L. Mondano, Operations Manager, 3M Co.
J. Harry Parker, Dir. of Operations, Cullinan Engineering Co., Inc.
Arthur Pingalore, Dir. of Training, Heald Corp., Cincinnati Milicron, Inc.
Don Sheehan, Digital Corp.
George R. Thomas, Director, Army Mechanics and Materials Research Ctr., Watertown, MA

Chemical Engineering

Dennis Cooper, Process Section Leader, Badger Engineers Inc.
Peter H. Farmer, R & D Section Manager, Monsanto Polymer Products Co.
Herbert M. Luz, Vice President, W. R. Grace and Company
Charles LaMantia, President, Koch Processing Systems
John McFeeley, Senior Manager, Polaroid Corporation
Michael M. Modan, Patent Strategy and Licensing Manager, General Electric Company
James J. Noble, Center for Environmental Management, Tufts University
Jack N. Robin, Assistant Deparment Manager, Stone and Webster Engineering Corporation
F. Greg Shinskey, The Foxboro Company
Fred Tarr, Consultant
Alfred E. Wechsler, Senior Vice President, Arthur D. Little, Inc.
Donald L. Wise, Vice President, Dynatech R/D Company
Francis C. Zevnik, Director, Kendall Company

Civil Engineering

Harl P. Aldrich, President, Haley & Aldrich
John Bethel, Jr., Pres., Bethel, Duncan & O'Rourke, Inc.
Bruce Hanes, Chairman, Civil Eng. Dept., Tufts University
John Jarnis, President, Barnes & Jarnis Inc.
J. Harry Parker, Dir. of Operations, Survey Division, Cullinan Engineering Company Inc.

Bartlett W. Paulding, Chief Engineering Geologist, Geotechnical Engineering, Inc.
Charles A. J. Theodore, President, Hometech Consultants, Inc

Electrical Engineering

Joseph F. Alibrandi, Plant Manager, Raytheon Co.
Walter S. Baird, President, Baird-Atomic, Inc.
W. Clare Brooks, Consultant, Andover
Martin Schilling, Project Director, Raytheon Co.
Paul G. Yewell, President, Yewell Associates, Inc.

Industrial Technology

Pamela Ashman, Methods Supervisor, Sanders Associates, Inc.
Wayne Donohue, Engineering Manager, Plastek Corporation
John Johnson, Service Center Manager, GenRad Corporation
Robert King, Group Supervisor of I. E. Training, GTE Sylvania Products Corp.
George Laramie, Manager, Senior Productivity Specialist, Computervision Corp.
John Leahy, Supervisor, AT&T Network Systems
Allen LeBoeuf, Area Manager, Lawrence Pumps, Inc.
Arthur Lochran, Manufacturing Engineering Manager, Wang Laboratories, Inc.
John Mikota, Mgr., Professional Recruitment and Mgmnt. Development, Continental Can Co.
Richard Phelan, Manager, Manufacturing and Product Engineering, Honeywell Corp.
Arthur Pingalore, Director of Training, Heald Corp., Cincinnati Milacron, Inc.
Richard Plutnicki, Quality Control Manager, Digital Equipment Corp.

Mechanical Engineering

John P. Appleton, Corporate V. P. and Technical Director, Thermo Electron Corp.
Erich K. Bender, Divisional Vice President, BBN Laboratories
Dennis A. Carpenter, Regional Market Devel. Mgr., Hewlett Packard Design Systems Group
Robert Cocozella, Director of Manufacturing Engineering, AVCO Systems Division
James Henshaw, Senior Staff Engineer, Avco Corp.
William A. Riblich, Vice President, Foster-Miller Associates
Richard J. Shea, Dir., Mechanics & Structural Integrity Lab., Army Mech. & Materials Research Ctr., Watertown, MA

Nuclear Engineering

Shelby T. Brewer, Combustion Engineering, Inc.
Andrew C. Kadak, Yankee Atomic Electric Company
Herbert J. C. Kouts, Brookhaven National Laboratory
John W. Landis, Stone & Webster Engineering Corporation
Robert L. Long, General Public Utilities
Gail H. Marcus, U. S. Nuclear Regulatory Commission
Peter F. Pasqua, University of Tennessee
George S. Thomas, Seabrook Station

Plastics Engineering

Prakash R. Ajmera, Plastics Technology, Owens-Illinois
Spencer Baba, Manager, Arco Chemical Co.
Frank Bradish, Premix, Inc.
Norman Brennan, Travenol Labs., Inc.

Clyde S. Brenner, Amoco Chemicals Corp.
Charles A. Breskin, Charles A. Breskin Associates, Inc.
Peter R. Bridenbaugh, Aluminum Company of America
Kurt E. Brunhuber, The Gillette Co.
William J. Burlant, The Kendall Co.
Edward Caughey, Allied Corp.
Charles K. Chiklis, Polaroid Corp.
Cliff P. Colwell, Manager, Bard Cardiosurgery Div., Plastics Proc. Div.
Thomas J. Conlon, Thomas J. Conlon, Inc.
Paul Dalton, Monsanto Co.
F. Reed Estabrook, Jr., Consultant
Robert E. Farrell, Reed Division of Package Machinery
Raymond Feasey, Supervisor, Eastman Kodak Co.
Angelo Firenze, Dynisco
Peter Foley, D.M.E.
Neil T. Flathers, OMYA Inc.
Robert D. Forger, Society of Plastics Engineers, Inc.
Iver J. Freeman, Consultant to the Plastics Industry
Paul Galanty, Allied Corporation
Michael Gigliotti, Michael Gigliotti & Assoc., Inc.
Lawrence Guilbault, Morton Thiokol, Inc.
Bernard M. Halpin, Jr., Army Materials & Mechanics Research Center
Judd Havrilla, Package Machinery Co.
Saleh A. Jabarin, Owens-Illinois
M. Barr Klaus, Cincinnati Milacron, Inc.
Howard Koenig, U.S. Tape, Inc.
Alan Litman, Xerox Corp.
Wolfgang Mack, Werner & Pfleiderer Corp.
Nathan L.M. McCarthy, Alliance Tool Corp.
James M. McDonough, Dow Chemical Co.
Robert McGee, Gerard Designs
Stephen Meacham, Reichhold Chemicals, Inc.
Ravi Mehra, Nalge Co., Division of Sybron Corp.
Ralph L. Mondano, 3M Company
Michael J. Moszkowicz, Eastman Kodak Co.
Robert C. Murphy, Borg-Warner Chemicals
Ray Naar, General Electric Co.
Philip S. Nachman, R.F. Hammond
Matthew H. Naitore, Plastics Technology
Christopher Nally, Upstate Plastics Machinery, Inc.
George E. Nelson, North American Operations
David M. Nolan, Allied Corp.
Tomitaro Ogawa, Sumitomo Plastics America, Inc.
Bradley Oldenburg, Manager, AMP Inc., Materials Development Laboratory
Jerry W. Perpich, Electrical Products Division/BM
Dennis Reager, Ford Company
Norm Rei, Morton Thiokol, Inc.
Joseph Rich, Mobay Chemical Center
Dominick V. Rosato, Consultant
William Schlich, General Electric Co.
George Schneider, Pellon Corp.

Joseph Skornicka, Supervisor, AC Spark Plug Div. of General Motors
George W. Smith, Consultant
Albert Spaak, Plastics Institute of America at Stevens Institute of Technology
James R. Stoppert, Dow Chemical, U.S.A.
Richard T. Studer, HPM Corp.
Jerry L. Sturdivant, Delco Remy, Div. of General Motors Corp.
Timothy Sullivan, Sanncor Industries
Paul V. Tebo, E.I. Dupont DeNemours & Co., Inc.
Dennis R. Tumminia, Dow Chemical Co.
J.L. Weinstein, U.C. Industries
Robert Welgos, Allied Corp.
James Worrall, Engineered Yards, Inc.
Ralph Wright, Rogers Corp.
W.R. Yates, Kendall Co., Lexington Laboratory
James Zimmerman, Ford Motor Company

BACCALAUREATE DEGREE PROGRAMS

The College of Engineering offers four and five year undergraduate programs leading to the degree of Bachelor of Science in Engineering, Bachelor of Science in Technology, and the Bachelor of Science in Engineering Technology; five-year dual-degree programs with the College of Liberal Arts leading to a Bachelor of Science degree in Engineering and a Bachelor of Arts; and five-year programs leading to both Bachelor of Science in Engineering and Master of Science in Engineering.

The degree of Bachelor of Science in Engineering is offered in the following fields: Chemical Engineering (a paper engineering option and a computer-aided process control option are available in the senior year), Civil Engineering, Electrical Engineering, Mechanical Engineering, Nuclear Engineering and Plastics Engineering. Course requirements for engineering degrees have been determined by specific professional objectives and are subject to the recommendations of the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). All engineering programs are accredited by the Engineering Accreditation Commission (EAC).

The curriculum in industrial technology, offered in both day and evening programs, leads to the degree of Bachelor of Science in Technology. The degree of Bachelor of Science in Engineering Technology is awarded in the areas of Civil Engineering Technology, Electronic Engineering Technology, and Mechanical Engineering Technology through the evening school of Continuing Education. Degree programs in industrial technology are accredited by the National Association of Industrial Technology (NAIT). The Civil, Electronic, and Mechanical Engineering Technology degrees, offered through the evening division, are accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET).

Courses of study in engineering, technology, and engineering technology provide a basic general education, scientific-technical training in the sciences, and a comprehensive introduction to an engineering or technical field. Students must select a single major field of study without reference to major and minor options which are available in the Bachelor of Arts and other Bachelor of Science degree programs. However, candidates for degrees in the College of Engineering may be permitted to elect additional majors in other colleges of the University, provided that all curriculum requirements for their degree program in the College of Engineering are satisfied.

Baccalaureate Options

Track II Program (5 year plan)

Track II Engineering is an alternative five year program. It allows a phased introduction to the rigorous engineering curriculum.

The purpose of Track II is to facilitate entry to an engineering discipline. Offered as an alternative to the standard four year program, this course of study prepares the student to enter any of the engineering fields on the completion of four semesters (two academic years) instead of the traditional two semesters. The critical pre-engineering course work which traditionally has been taken in freshman year is spread over two years. This course work (two semesters of calculus, physics, and chemistry) is both academically rigorous and time-consuming and, for many students in the regular program, overwhelming. The Track II extended program permits consecutive, overlapping scheduling of these courses: chemistry in the first semester, pre-calculus mathematics and chemistry in the second semester, and calculus and physics in each of the third and fourth semesters.

Students in Track II also take courses in the required distribution areas of English composition, social sciences and, the humanities. A full course load during the four semesters of the program consists of 12 to 14 semester credits compared with 17 credits required in the standard curriculum.

Students in both the standard four year program and in Track II can accelerate their progress toward graduation during the last three years by taking (optional) summer courses.

Cooperative Education Program: (5-year plan)

The cooperative education program for undergraduates combines academic studies with work experience in appropriate positions in the public or private sectors. It permits students to participate in an alternating schedule of study and work that is related to their academic fields of study and to receive academic credit for the work experience.

The College of Engineering is a full participant in the cooperative education program. All engineering and technology students may participate in this program which enables completion of a baccalaureate program in five years.

Dual Degree Program: Bachelor of Science in Engineering/Bachelor of Arts

The College of Engineering and the College of Liberal Arts offer a five year dual degree program which permits the student to earn a Bachelor of Science in Engineering degree in a designated field (civil, chemical, electrical, mechanical, nuclear or plastics engineering) while simultaneously earning a Bachelor of Arts degree in American studies, art, English, foreign languages, history, political science, philosophy, psychology, or sociology.

Students entering the dual degree program must meet the entrance requirements of both colleges and must complete the University core requirement. Curricula for dual degree programs are approved by the faculties of the participating colleges and must be completed as prescribed. Both the Bachelor of Arts (BA) and the Bachelor of Science in Engineering (BS Eng.) degrees are conferred at the end of the fifth year. The conferral of the Bachelor of Arts degree is contingent upon the completion of all the requirements for the degree of Bachelor of Science in Engineering.

Students entering the engineering/liberal arts dual degree program should refer to the specific requirements of the appropriate engineering and liberal arts curricula which are found in this bulletin. Further information on these requirements is available from the Dean of the College of Engineering or from the Dean of the College of Liberal Arts.

Dual-Degree Program with other Colleges (3+2 plan)

A formal "3+2" engineering program is jointly offered by St. Anselm College and the University of Lowell. This program enables a student to gain both a liberal arts education and a professional engineering education, earning a Bachelor of Arts degree from St. Anselm College and a Bachelor of Science Degree in Engineering from the University of Lowell. Students in this program enter St. Anselm College and study for three years, gaining broad liberal arts training combined with necessary pre-engineering courses. The student then enrolls at the University of Lowell for two additional years, completing a professional engineering program.

Combined Bachelor of Science in Engineering/Master of Science in Engineering Program (5-year plan)

In order to encourage outstanding undergraduate students to continue their studies toward an advanced degree, the College of Engineering and the Graduate School offer a program of accelerated study which leads to a Bachelor of Science in Engineering/Master of Science in Engineering degree. Students taking full advantage of the combined program ordinarily finish the Master of Science in Engineering degree work at the end of the fifth year of study.

To be eligible to enter this course of study, a student must file a formal Graduate School application in the junior year. Applicants for this program are not required to take the Graduate Record Examination. Upon recommendation of the student's advisor and with the approval of the department graduate admissions committee and the Dean of the Graduate School, the student will be admitted as a provisional graduate student during the second semester of the senior year.

Certain graduate or advanced undergraduate (400 level) courses that an undergraduate in this program takes during the senior year may be used to satisfy both the graduate and undergraduate degree requirements within a limit of credits established by each department.

A student in this program may be eligible for financial assistance, i.e., fellowships and teaching assistantships, during the fifth year of study. Acceptance of this assistance and the attendant responsibilities may delay the completion of the program beyond the five years.

GENERAL COLLEGE OF ENGINEERING REQUIREMENTS

Each candidate for the undergraduate degree must satisfy the general requirements of the University of Lowell in order to graduate. The student must also meet the specific academic requirements of the College of Engineering as indicated in this section, as well as complete all credits and courses required by the department in which the student majors. The number of credits required for the completion of each College of Engineering program is established by the department.

Students enrolled in the Industrial Technology program take freshman year courses tailored to the special interests of that field. All other freshmen (except in Track II) pursue an identical first-year course of study which includes calculus, physics, chemistry, and college writing.

The freshman program includes courses in engineering design and computer programming to prepare students to meet the requirements of technical coursework. These courses introduce students to problem solving tools which are applied in the sophomore year when specialized coursework in a field is taken.

Introduction to Engineering Design (25-101) requires students to develop a technical solution to a particular problem and to consider the effects of this solution on the environment. The course introduces students to the engineering design process, the method used by engineers to solve open ended problems. Techniques of engineering graphics, which is the medium of communication in engineering design, are also developed and applied.

By completing Computer Programming for Engineers (25-127) in the first year, students learn a time-shared computer system to solve engineering problems. Using the FORTRAN-77 language and a specially designed software package, students solve problems at their terminals. The computer corrects and grades the solutions and returns this information on the terminal screen. The teacher is thus free to concentrate on teaching the FORTRAN language and programming.

Students who have completed their freshman programs with a grade-point average of 2.50 or better automatically qualify for admission to the sophomore program of their choice. Students who fail to achieve that required average will be admitted to the sophomore year of engineering programs only upon the recommendation of appropriate departmental committees.

In addition to satisfying University retention and graduation requirements, each candidate for a degree in the College of Engineering must achieve the following grade-point averages in departmentally designated courses: 1.70 by the end of the sophomore year with 60 course hours completed; 1.90 by the end of the junior year with 90 course hours completed; and 2.00 for graduation. Students who fail to achieve the specified sophomore or junior year average in departmentally designated courses have not made satisfactory progress toward their degrees and will be dismissed from the college for inadequate scholarship unless they are granted continued matriculation status by their department and the academic standards committee of the college.

Individuals who are not granted continued matriculation in the College of Engineering, but who satisfy University retention requirements, may file for intercollegiate transfer within the University. Students who are dropped from the College of Engineering and who are ineligible to file for intercollegiate transfer or who are denied admission to another college following application for intercollegiate transfer are dropped from the University.

Professional Programs Of Study

Students who are enrolled in the College of Engineering are, of necessity, committed to pursue one of the established degree-granting programs. They are, therefore, required to make an initial declaration of a degree program (course of study) upon enrollment.

Change of Program

Students who wish to change their declarations of program within the College of Engineering are required to follow the procedure stipulated in the general bulletin under "University Academic Policies: Change of Major within College of Enrollment." It should be noted that College of Engineering students who change their programs within the College of Engineering after the first semester of the junior year should expect to have to take semester credits beyond the minimum degree requirement, and thus extend the normal four-year period of study.

Students who wish to change from engineering or industrial technology to a major which is offered by another college within the University of Lowell must apply for an intercollegiate transfer. These procedures are described under "University Academic Policies: Change of Major with Intercollegiate Transfer."

Qualified students from other colleges in the University of Lowell may transfer into degree programs of the College of Engineering using the same procedure. However, these students may expect to extend their period of study beyond the normal four-year period, particularly if they transfer after the first semester of the sophomore year.

Declaration of Secondary Major

Candidates for degrees in the College of Engineering may be permitted to elect additional majors offered in other colleges of the University provided that all curriculum requirements in engineering or industrial technology are satisfied.

Engineering students who wish to take on a secondary major which is offered by another college must formalize this intent by the start of the junior year. At that time the student is also required to submit for approval his or her intended program of study to the advisor in the department offering the secondary major. It should be noted that in most cases the election of an additional major will extend the normal four-year period of undergraduate study. Students who elect to take a secondary major in another college are candidates for a degree in the College of Engineering only. A student in the College of Engineering who pursues an academic major in another college is subject to all degree requirements of the College of Engineering and is subject only to major course requirements specified by the department of the secondary major. For a complete statement of University Policy on double majors, refer to "University Academic Policies: Major Field Requirements," which appears elsewhere in this bulletin.

Transfer Policies of the College of Engineering

General

It is the policy of the College of Engineering to accept transfer students from other institutions as well as from other colleges within the University of Lowell. Students may expect recognition of previously completed courses if they are equivalent to those which are specified by the curricula of the College of Engineering. Transfer students are required to have at least a 2.5 grade-point average in order to be admitted to the College of Engineering.

Transfer from Other Institutions

Courses which are transferred from other institutions are initially evaluated by the office of admissions in terms of general University of Lowell requirements before a student is admitted to the University. Professional courses are subsequently evaluated by the departments in which the student has been accepted. Credit is given for completed courses where the grade is "C" (2.0 on a 4.0 scale) or better.

The University of Lowell subscribes to the Commonwealth Transfer Compact. Under this compact, the holder of an associate degree from a compact institution receives up to 67 credits for this work toward a Bachelor of Science in engineering or technology. Courses which are transferred to the University of Lowell under the provisions of the Commonwealth Transfer Compact, but which do not meet the credit requirements of the College of Engineering, or which are not acceptable as unrestricted elective courses, will be listed on the student's transcript, but will not apply to the minimum degree requirements.

In the event that a student who has first transferred to some other college in the University of Lowell under the Commonwealth Transfer Compact and subsequently makes a transfer to the College of Engineering, all previously completed courses, including transferred courses from other compact institutions, will be re-evaluated in terms of their applicability toward degree requirements of the College of Engineering.

The policies of each of the colleges in the University determine the applicability of grades received in transfer to the grade-point average of the student's major at the University of Lowell. It is the policy of the College of Engineering not to count such grades for the purpose of determining the student's grade-point average in his or her professional area.

2 + 2 Transfer Program

The College of Engineering has been a leader in the development and implementation of 2 + 2 Programs. More and more students who are interested in earning a Bachelor of Science degree in one of the engineering disciplines pursue their first two years of the curriculum at selected community and state colleges and complete the degree requirements during two final years at the University of Lowell. The program is ideal from the standpoint of the student who is not ready to enter a four-year college, allowing the participant to ease into college life while still remaining close to home and within the environment of a smaller college.

The contractual agreements among participating schools require an on-going review of coursework normally offered in the first two years. Curricula and other requirements are carefully established and examined by faculty at both institutions and students successfully completing the freshman and sophomore years at the participating institutions with a 3.0 average are guaranteed admission to the final two years in the College of Engineering at the University of Lowell.

Transfer agreements vary with each institution participating in the 2 + 2 program. Some participating colleges offer programs which prepare students for transfer to mechanical and electrical engineering; programs in other schools lead to entry into chemical or civil engineering. High school students who are considering this program should consult the office of admissions at the University of Lowell for information about available programs in participating instituitions.

Repetition of Transferred Courses

A student who has been granted transfer credit from another institution, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be subsequently advised to repeat the transferred work at the University of Lowell. Such cases arise when preparation of the student is demonstrably inadequate to allow successful performance.

To repeat a transferred course a student must file an academic petition with the college dean. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a "request to revoke recognition" statement to dispose of the previously transferred course credit.

Intercollegiate Transfer to the College of Engineering

Students wishing to transfer to the College of Engineering from another college within the University of Lowell, or from a baccalaureate (degree granting) Continuing Education program of the Evening School, must file a form for change of major, together with a transcript, with the Dean of the College of Engineering and with the appropriate engineering department head. Petitions for transfer must be filed no later than November 1 in order to transfer in the spring semester, and no later than April 1 in order to transfer in the fall semester.

Any student who wishes to transfer from another college in the University to the College of Engineering must have a minimum grade-point average of 2.50. Irrespective of the grade received, all courses which may not be applied to the College of Engineering program requirements will be deleted from the student's cumulative grade-point average.

For further procedural details about the University's policies concerning intercollegiate transfers, students are referred to "University Academic Policies: Change of Major with Intercollegiate Transfer", elsewhere in this bulletin.

COLLEGE OF ENGINEERING: Course Prefix Codes

The University uses a prefix number for each department. Course prefixes assigned by the College of Engineering are as follows:

Chemical Engineering	10	Mechanical Engineering	22
Paper Engineering	11	Nuclear Engineering	24
Civil Engineering	14	Intracollegiate Engineering Courses	25
Electrical Engineering	16	Plastics Engineering	26
Industrial Technology	20		

INTRACOLLEGIATE ENGINEERING COURSES (Course Prefix: 25)

25-101 INTRODUCTION TO ENGINEERING DESIGN I,II(1-2)2

This course introduces engineering design as the method engineers use to solve open-ended problems. Techniques in engineering graphics are developed and applied as the media of communication in design. Thought processes associated with the development of creative and innovative design ideas are discussed and applied. The subjects of experimental and analytical modeling are introduced and related to the design process. Case studies are discussed as examples of the application of the design process.

25-127 COMPUTER PROGRAMMING FOR ENGINEERS I,II(1-2)2

The course teaches students to use a time-shared computer system to solve engineering problems. FORTRAN-77 is the programming language used. The steps of program development are stressed, including problem definition and analysis, algorithm design, coding, debugging, and verification of results. Students are required to run a substantial number of programs. They are taught to use a text editor and interface with the system throughout their program preparation, compilation, linking, and program verification phases.

25-203 TECHNOLOGY AND HUMAN VALUES I I(3-0)3

This is a team-taught course about the interrelationship of technology and human values. It begins with an exploration of the Industrial Revolution in Lowell, followed by an examination of topics drawn from areas such as agriculture, Third World development, population control, energy and natural resources, household technology, and transportation. Unifying themes are the values associated with science and technology, the role and responsibility of the scientist and technologist, and the question of whether scientific and technological development should be and can be controlled. This course is cross listed with 59-203, in the interdisciplinary course listings of the College of Liberal Arts.

25-204 TECHNOLOGY AND HUMAN VALUES II II(3-0)3

A continuation of 25-203. This course is cross listed with 59-204 which will be found in the interdisciplinary course listings of the College of Liberal Arts.

25-295 MATERIALS SCIENCE I,II(3-0)3

The behavior of engineering materials is studied in a systematic manner to develop an understanding of why materials behave as they do. The main emphasis is on the relationship of the mechanical behavior and internal material structure. Other properties such as thermal, electrical, optical, corrosion, and radiation are also surveyed. The topics of study include atomic and crystalline structure; thermodynamics of phase relationships and structural change; and elasticity, plasticity, viscoelasticity, and fracture mechanics. The mechanical properties, processing methods, and application of metals, polymers, ceramics, and composites as structural materials are examined. Prerequisites: 84-122,95-145.

DEPARTMENT OF CHEMICAL ENGINEERING

Francis Bonner, Department Head

Professors: Francis Bonner, Huan-Yang Chang, Charles J. Higgins, Dominick A. Sama, Thomas Vaselos

Associate Professors: Alfred A. Donatelli, Richard A. Eppler, H. William Flood, John W. Walkinshaw

Assistant Professor: Steven M. Slater

Chemical engineering is the profession in which a knowledge of mathematics, chemistry, and other natural sciences, gained by study, experience, and practice, is applied with judgement to develop economical ways of using materials and energy for the benefit of mankind (A.I.Ch.E.-1983).

Engineering science, concerned with chemical reactions, reaction kinetics, equilibria, and mass and energy transport, is one leg of the chemical engineering profession. The second leg is concerned with the knowledge of economics as applied to the operation and implementation of valid business plans to permit intelligent management decision-making. The third increasingly important leg is concerned with understanding the social impact of actions taken as a result of a chemical engineering project.

The traditional chemical process industries have shown signs of maturing after several decades of accelerated growth. This is having a profound effect upon the profession, while creating rich opportunities. New areas of growth are emerging that demand the skills that are an integral part of the chemical engineering heritage, including:

Computer-aided process control. With the world-wide increase in energy costs in the 1970's, emphasis is being placed on technologies that use energy and petroleum-based feedstocks in a more effective and efficient manner. Widespread use of computer-aided process controls will be required to achieve efficient design performance. The department now offers an option in computer-aided process control that permits the graduating senior to qualify for entry-level positions in this field.

Biotechnology. The growth of biotechnology-based methods to produce pharmaceuticals, food products, and agrichemicals has been spectacular, although the size of the industry is still relatively small. Almost all of the major chemical process companies have substantial new investments aimed at various segments of this developing field. The value of the chemical engineer is just beginning to be recognized and a significant demand for people with a biotechnology background can be expected. A new program in this area, offered jointly with the chemistry and biology departments, is under study.

Microelectronics. The manufacture of microelectronic devices increasingly is requiring the skills of trained chemical engineers. In addition to developing improved manufacturing methods, graduates of the department have been employed to develop methods of handling the liquid, solid, and gaseous wastes that result from the manufacturing processes. A new graduate course in Electronic Materials Processing marks the beginning of the development of this program.

Paper engineering. The need for paper and paper products has continued to grow. Increasingly, control of the complex manufacturing operations has required the use of computer systems and particular attention to product quality control and to regulation of solid, liquid, and gaseous emissions. The department has offered the chemical engineer an option in paper engineering for a number of years.

The chemical engineering curriculum provides maximum flexibility to students, and encourages individual students to undertake original research. Considerable emphasis is placed on oral and written reports to provide students with the necessary experience for the professional world where such reports are an important part of a chemical engineer's work.

A variety of support is provided for students in chemical engineering to enhance their professional development. A number of scholarships ($500 per year) are available to qualified students in the paper engineering option. A tuition waver is available to selected Massachusetts residents. Undergraduates are encouraged to gain practical experience and are directed to summer employment in the chemical or paper industries. The department also encourages students to take the Engineering In Training examinations in order to qualify as Registered Professional Engineers following graduation. In addition, students have the opportunity to join the student chapter of the American Institute of Chemical Engineers and/or the student chapter of the Technical Association of the Pulp and Paper Industry. A local chapter of the Chemical Engineeering Honor Society, Omega Chi Epsilon, is open to qualified students.

COURSE OF STUDY FOR CHEMICAL ENGINEERING (Bachelor of Science in Engineering)

Freshman Year

Fall Semester		Spring Semester	
25-101 Intro. Eng. Design*	2	25-127 Computer Programming*	2
42-101 College Writing I	3	42-102 College Writing II	3
84-121 Chemistry I+	3	84-122 Chemistry II+	3
84-123 Chemistry Lab	1	84-124 Chemistry Lab	1
92-131 Calculus I+	4	92-132 Calculus II+	4
95-141 Physics I+	3	95-144 Physics II+	3
96-141 Fund. Exp. Physics I	1	96-144 Fund. Exp. Phys. II	1
39- Physical Ed.	1	39- Physical Ed.	1
	18		18

* May be taken either semester.

+ Appropriate honors courses may be substituted.

Sophomore Year

Fall Semester		
10-203	Chem. Eng. Calc. I	3
10-207	Computers in Chem. Eng.	2
14-217	Statics & Mechanics of Materials	3
84-221	Organic Chemistry IA	3
92-231	Calculus III*	4
		15

Spring Semester		
10-204	Chem. Eng. Calc. II	3
10-206	Fluid Mechanics	3
64-202	Economics II	3
84-220	Organic Chemistry Lab	1
84-222	Organic Chemistry IIA	3
92-234	Differential Equations	3
	Area I or II Elective	3
		19

Junior Year

Fall Semester		
10-305	Heat Transfer	3
10-311	Chem. Eng. Thermodyn.	3
10-315	Unit Opn. Lab I	1
84-344	Physical Chemistry I	3
92-317	Appl. Math. Chem. Eng.	3
	Area I or II Elective	3
		16

Spring Semester		
10-306	Transport Phenomena	3
10-308	Engineering Materials	3
10-310	Separation Processes	3
10-316	Unit Operations Lab II	1
84-345	Physical Chemistry II	3
84-347	Physical Chemistry Lab II	1
	Area I or II Elective	3
		17

Senior Year

Fall Semester		
10-403	Kinetics & Reactor Des.	3
10-409	Econ. & Proc. Anal.	3
10-413	Proc. Dyn. & Control	3
10-	Chem. Eng. Elective	3
	Undesignated Elective**	3
	Area I or II Elective	3
		18

Spring Semester		
10-410	Chemical Plant Design	3
10-416	Proc. Operations Lab	2
10-	Chem. Eng. Elective	3
84-	Advanced Chemistry Elective	3
	Undesignated Elective**	3
	Area I or II Elective	3
		17

* May be taken either semester.

** ROTC students may elect 29-401, 29-402. In lieu of ROTC, undesignated electives may be selected from upper level courses in the College of Engineering and/or Pure and Applied Science.

Students electing the option in paper engineering must take the following courses in the junior and/or senior year as chemical engineering and undesignated electives.

10-402	Eng. Anal. of Coating Systems	3
10-405	Design of Paper	4
10-501	Paper Industry Process Analysis	3
10-504	Process Calcs. of Pulp & Paper Processes	3

Students electing the option in computer-aided process control must take the following courses in the senior year as chemical engineering and undesignated electives.

10-516	Microprocessor Control I	3
10-518	Microprocessor Control II	3
10-522	Computer-Aided Chemical Process Design	3
10-530	Advanced Control Strategies	3

Five Year BS Engineering/MS Engineering Program

The Department of Chemical Engineering offers a 5-year BS/MS program in Chemical Engineering or Paper Engineering. An undergraduate student electing this program may utilize the program's technical electives to partially satisfy the course requirements of the Master of Science in Engineering degree program. A student wishing to elect this program must notify the department chairperson during the junior year. On acceptance by the committee, he or she must make a formal application to the University Graduate School.

Chemical Engineering (Course Prefix: 10)

10-203 CHEMICAL ENGINEERING CALCULATIONS I **I(3-0)3**
Introduction to the field of chemical engineering and the solution of problems involving units and dimensions, mass balances, flow sheets, and gas relationships. Prerequisite: 84-126 or 84-136.

10-204 CHEMICAL ENGINEERING CALCULATIONS II **II(3-0)3**
Continuation of Chemical Engineering Calculations, including real gas relationships, humidity, energy balances, and the combined mass-energy balance systems. Prerequisite: 10-203.

10-206 FLUID MECHANICS **II(3-0)3**
Introduction to fluid statics and application of fluid mechanics principles to the analysis and design of fluid systems. Friction factor, pressure drops in laminar and turbulent flow, compressible flow, drag and particulate flow, pumps, mixing, and filtration are covered.

10-207 COMPUTERS IN CHEMICAL ENGINEERING **I(2-0)2**
Numerical methods, including linear and non-linear equations, matrices, regression, integration, differentiation, and ordinary differential equations. Eight to ten problems are done by each student using the University computer facilities.

10-305 HEAT TRANSFER **I(3-0)3**
Fundamental principles of heat transmission by conduction, convection, radiation and evaporation. Applications of these principles to the solution of industrial heat transfer problems and to the design calculations for heat exchange situations. Prerequisites: 10-204, 10-206.

10-306 TRANSPORT PHENOMENA **II(3-0)3**
Introduction to the theory of the transport processes. Integral and differential approaches are used to develop the macroscopic and microscopic forms of the conservation laws. The conservation laws are used to solve practical problems in the chemical industry.

10-308 ENGINEERING MATERIALS **II(3-0)3**
Study of materials for engineering construction and chemical purposes from standpoint of physical and chemical properties, corrosion, and introductory electrochemistry. Structures of metals, non-metals, and polymeric materials. Structure of materials related to ultimate performance. Prerequisites: 84-126,84-222.

10-310 SEPARATION PROCESSES **II(3-0)3**
Introduction to distillation, absorption, extraction, and other stagewise and differential contact separations. Material and energy balances, mass transfer, and equilibrium relations. Graphical and numerical methods with emphasis on computer solutions. Major open-ended separation system designs. Prerequisites: 10-203,10-204,10-207,10-311.

10-311 CHEMICAL ENGINEERING THERMODYNAMICS **I(3-0)3**
Development of the first and second laws of thermodynamics. P-V-T relations, mathematics of property changes, generalized correlations of thermodynamic properties, application of thermodynamics to problems of phase and chemical equilibria. Prerequisite: 10-204.

10-315 UNIT OPERATIONS LABORATORY I **I(0-3)1**
Experimental projects dealing with fluid flow. Written reports required. Prerequisite: 10-203,10-206. Corequisite: 10-305.

10-316 UNIT OPERATIONS LABORATORY II **II(0-3)1**
Experimental projects dealing with heat transfer. Written reports required. Prerequisite: 10-315. Corequisite: 10-306.

10-402 ENGINEERING ANALYSIS OF COATING AND CONVERTING SYSTEMS **II(2-3)3**
Lectures and problems concerned with the engineering design, technology and economics of paper and paperboard processes. Rheology and engineering properties of coating materials. Mechanical processes, coating, impregnating, laminating, and printing processes are discussed in detail. Prerequisite: Permission of instructor.

10-403 PROCESS REACTOR DESIGN **I(3-0)3**
Basic concepts of homogeneous and heterogeneous reactions. Design of batch, semibatch, CSTR, and plug-flow reactors for homogeneous reactions; catalytic fixed bed, moving bed, slurry, trickle bed, fluidized bed, and noncatalytic reactors for heterogeneous reactions. Optimization of chemical reactors. Use of digital computer in solution of problems. Prerequisites: 10-306,10-310,10-311,84-345,92-317.

10-405 DESIGN OF PAPERS **I(3-3)4**
Fundamentals of the mechanical and optical testing of paper and allied products. Discussion of engineering mechanics involved in various testing procedures. Statistical analysis of test data. Structure of materials revealed by physical tests. Laboratory projects designed to illustrate problems in development of paper products and associated required processes. Prerequisite: permission of instructor.

10-409 ECONOMICS AND PROCESS ANALYSIS **I(3-0)3**
Economic evaluation of manufacturing firms. Accounting terms, time value of money, evaluation of investment alternatives. A major part of the required work is a written plan for establishing a manufacturing enterprise. Prerequisite: 10-310.

10-410 CHEMICAL PLANT DESIGN **II(3-0)3**
This course is the logical continuation of 10-409. The principles of technical and economic evaluation are applied to two specific chemical engineering problems, each consuming approximately half of the semester. A group of students is given a statement of the problem. They are required to find information on raw materials, products, thermodynamic parameters and plant practices in order to develop the assumptions required to carry out an examination of technical and economic feasibility. Each group generates a final report for each problem. Homework is assigned to define and solve particular aspects of assigned problems. Prerequisites: 10-403,10-409.

10-413 PROCESS DYNAMICS AND CONTROL **I(3-0)3**
An introduction to chemical process control, description of processes and equipment by differential equations and the LaPlace transform. Development of block diagrams. System stability is studied by both root locus and frequency response methods. May be taken for graduate credit. Prerequisites: 92-317,10-305,10-306,10-310.

10-416 PROCESS OPERATIONS LABORATORY **I,II(1-3)2**
Experimental projects dealing with heat and mass transfer, separations and process control. Written and oral reports required. Prerequisite: 10-315,10-316. Corequisite: 10-413.

10-419 SPECIAL SENIOR PROJECTS **Credits Arranged**
Original research projects primarily in the chemical engineering field and supervised by a staff member of the department. Written reports required. Prerequisite: permission of instructor.

10-420 SPECIAL SENIOR PROJECTS **Credits Arranged**
Continuation of 10-419.

Primarily for Graduate Students, but open to undergraduates with permission of the instructor.

10-501 PAPER INDUSTRY PROCESS ANALYSIS **I(3-0)3**
Lectures dealing with the engineering processes of fiber separation from raw materials, fiber purification and mechanical processing of fiber and sheet formation. Chemical engineering theory is applied to the analysis of these operations. Prerequisite: permission of instructor.

10-502 PRINCIPLES OF CHEMICAL ENGINEERING **I(3-0)3**
An introduction to chemical process engineering for non-majors including chemists and biologists. Covers material and energy balances, thermal properties, and flow in pipes. Processes are illustrated using a variety of homework assignments. Prerequisite: permission of instructor

10-503 MASS TRANSFER OPERATIONS I **I(3-0)3**
Detailed coverage of the fundamentals of separation processes of absorption and extraction. Degrees of freedom, phase equilibrium diagrams, graphical techniques, molecular diffusion, interphase mass transfer, mass transfer, and simultaneous chemical reaction. Design principles for multi-stage countercurrent contactors and continuous differential contact columns. Prerequisite: permission of instructor.

10-504 PROCESS CALCULATIONS OF PAPER AND PULP PROCESSES **II(3-0)3**
A review of chemical engineering principles by application to the specific design and processes encountered in the pulp and paper industry. Prerequisite: permission of instructor.

10-506 COLLOID CHEMISTRY FOR CHEMICAL ENGINEERS **II(3-0)3**
Colloid chemistry principles; zeta potential and its applications; and specific problems involving surface chemistry and physics. Prerequisite: permission of instructor.

10-509 MATHEMATICAL APPLICATIONS IN CHEMICAL ENGINEERING **I(3-0)3**
Applications of ordinary and partial differential and finite difference equations, integral transforms, and generating functions in the solution of chemical engineering problems is emphasized with numerous real life examples. Prerequisite: permission of instructor.

10-514 CHEMICAL PROCESS OPTIMIZATION **II(3-0)3**
An advanced study of modern optimization techniques having applications in process economics, process analysis, process dynamics, process kinetics, and process design. Methods such as linear, nonlinear, geometric, dynamic programmings, discrete, and continuous maximum principles are examined. Prerequisite: permission of instructor.

10-516 MICROPROCESSOR CONTROL **I(2-3)3**
Single board computers and single chip controllers and how they are used in chemical process control. Prerequisite: permission of instructor.

10-517 MASS TRANSFER OPERATIONS II **I(3-0)3**
Fundamentals and modeling techniques for the separation process of distillation. Flash

distillation, batch distillation, multicomponent distillation. Shortcut design method, Lewis-Matheson method, Thiele-Geddes method, Wang-Henke method, other matrix methods. Optimization. Prerequisite: permission of instructor.

10-518 MICROPROCESSOR CONTROL II **II(2-3)3**
Programming methods for using minicomputers as process controllers, and interfacing requirements and communications. Laboratory projects include both software and hardware applications. Prerequisite: 10-516.

10-520 ADVANCED THERMODYNAMICS **II(3-0)3**
The central theme of this course is the use of the Second Law of Thermodynamics to reduce energy consumption in operations and processes in the chemical industry. Lost work analysis techniques are developed for the evaluation of thermodynamic processes. Areas of study include power cycles, refrigeration, and distillation. Prerequisite: permission of instructor.

10-521 INTRODUCTION TO ENVIRONMENTAL ENGINEERING **I(3-0)3**
Introduction to air, water, and toxic (hazardous) wastes. Definition of assessment parameters necessary to resolving environmental problems. Development of process calculations on pollution abatement systems. Prerequisite: permission of instructor.

10-522 COMPUTER-AIDED CHEMICAL PROCESS DESIGN **I,II(3-0)3**
Process synthesis, definition, and characterization. Introduction to modular process simulation packages such as FLOWTRAN and ASPEN PLUS™. Recycle and tear stream analysis. Stream convergence. Unit operation models. Flowsheet manipulation. Data records and physical property estimation techniques. Prerequisite: permission of instruction.

10-523 ELECTRONIC MATERIALS PROCESSING **I,II(3-0)3**
Materials processing methods in electronics and related industries,to include crystal contamination control, growth, diffusion, etching, epitaxy, ion implantation, lithography, and others. Prerequisite: permission of instructor.

10-525 CONSTRUCTION AND USE OF PACKAGING MATERIALS **II(2-3)3**
Jointly given by Chemical Engineering and Plastics Engineering. A survey of package engineering, including paper/paperboard and plastics, as well as glass and metal products. Laboratory projects will reinforce the classroom lecture material. Prerequisite: permission of instructor.

10-528 ADVANCED TRANSPORT PHENOMENA **II(3-0)3**
An advanced study of the mechanism of momentum, heat, and mass transfer. The equations of continuity, motion, and energy are used to examine steady and unsteady state processes. Considerable emphasis is placed upon solutions to problems. Prerequisite: permission of instructor.

10-529 PROCESS INTEGRATION FOR THE EFFICIENT USE OF ENERGY **I(3-0)3**
A critical study of the integration of heat and power requirements in chemical process plants. Topics to be studied include steam balances, heat pumps, heat exchangers, and heat recovery network design. Prerequisite: permission of instructor.

10-530 ADVANCED CONTROL STRATEGIES **II(3-0)3**
An introduction to some of the common control strategies applied to the design of complex chemical process control systems. Prerequisite: permission of the instructor.

10-601 CHEMICAL ENGINEERING SEMINAR **I(1-0)1**

10-602 CHEMICAL ENGINEERING SEMINAR **II(1-0)1**
Required of all graduate students.

10-651 SELECTED TOPICS IN CHEMICAL ENGINEERING **(3-0)3**
Advanced topics in the various fields of chemical engineering. Content may vary from year to year to reflect contemporary applications.

10-652 SELECTED TOPICS IN CHEMICAL ENGINEERING **(3-0)3**

10-701 GRADUATE RESEARCH IN CHEMICAL ENGINEERING **(0-9)3**
Every graduate student is required to perform thesis or project research under the supervision of a senior chemical engineering staff member. The thesis or project must be approved by an examining committee appointed by the department head.

10-702 GRADUATE RESEARCH IN CHEMICAL ENGINEERING **(0-9)3**

10-751 ADVANCED PROJECTS IN CHEMICAL ENGINEERING **(0-9)3**
Special projects laboratory undertaken to expand knowledge in specific fields not necessarily related to a thesis. Content of project, hour assigned, and supervisor must be approved by the department head. Prerequisite: permission of department.

Paper Engineering (Course Prefix: 11)

11-503,11-504 ADVANCED CONVERTING PROCESSES **(2-3)(2-3)6**
Specific converting processes. Analysis of water and solvent based coating processes, extrusion, and hot melts. Latest techniques used by the converting industry, involving mechanical and chemical operations. Engineering analysis of processes. Oral and written reports, plant visits, and laboratory assignments. Prerequisite: permission of instructor.

11-505 THE PHYSICS OF PAPER **(3-0)3**
Structures of fibers from a fundamental viewpoint and their effect on strength and other properties of sheets made of the fibers. Comparison of cellulosic fibers and synthetic fibers. Engineering properties of fibrous materials. Prerequisite: permission of instructor.

11-506 NEW TECHNIQUES IN THE PAPER INDUSTRY **(3-0)3**
Lectures and discussions of new developments in engineering, design, and application of physical and chemical principles in the manufacture of paper products. Economic comparisons of new processes. Oral and written reports, plant visits, and laboratory assignments. Prerequisite: permission of instructor.

11-507 FUNDAMENTALS OF REPROGRAPHY **(3-0)3**
An in-depth study of replicating and imaging systems from carbon paper to xerography and halography, covering theory and principles of operation, design and development of hardware and supplies, typical specifications, and a cursory economic evaluation of these systems. Because of the unique technical character of this new field, a review of copyright, patents, and trade secrets is provided. The current state of the art is reviewed and the potential represented by recent developments in the field examined. Prerequisite: permission of instructor.

11-508 ADVANCED PAPER SYSTEMS ANALYSIS **(3-0)3**
A study of the instrumentation and measurement systems used to monitor and control the processes of pulp and papermaking. Discussions consider the fundamental properties measured, as well as the components in the process which interfere with the measurements. Prerequisite: permission of instructor.

11-512 ADVANCED FIBER PROCESSING (3-0)3
A study of fiber properties as related to fiber processing. Treatment of various theories of fiber processing. Discussion of mechanical treatments of fibers on the wet and dry properties of papers made from these fibers. Prerequisite: permission of instructor.

11-651 SELECTED TOPICS IN PAPER ENGINEERING (3-0)3
Advanced topics in the various fields of paper engineering. Contents may vary from year to year to reflect contemporary applications of paper engineering. Prerequisite: permission of instructor.

11-652 SELECTED TOPICS IN PAPER ENGINEERING (3-0)3

11-701 GRADUATE RESEARCH IN PAPER ENGINEERING (0-9)3
Every graduate student is required to write a thesis on original research work done under the supervision of a senior committee appointed by the department head.

11-702 GRADUATE RESEARCH IN PAPER ENGINEERING (0-9)3

DEPARTMENT OF CIVIL ENGINEERING

Donald Leitch, Department Head

Professors: Nathan Gartner, Donald Leitch, William Moeller, Charles Ott, Burton Segall

Associate Professors: Frank Alberti, Mukti Das, John Sewell, Louis Tartaglione.

Assistant Professors: Susan Faraji, Rezene Medhani, A. Mark Ratner

Civil engineering is charged with the planning, design, construction, and operation of works vital to man's activities in relationship to the environment.

The concerns of the civil engineer include engineering structures or total facilities to accommodate residential, business, industrial, scientific, and recreational pursuits; planning, designing and managing transportation systems; and the gathering and processing of environmental information. Civil engineers are called upon to adapt natural or man-made materials for productive use. In this role they are involved in the control and management of the forces of nature as they affect the environment, or are dealing with the treatment and disposal of solid, liquid, and air-borne waste.

CIVIL ENGINEERING PROGRAM

Graduates in civil engineering are prepared to apply their training in the widest range of society's projects. They are employed to work in the development of highways, railroads, airports, and those areas having to do with water and waterways such as bridges, dams, canals, and levees. They are also concerned with water treatment plants and distribution systems for municipal and industrial water supplies, as well as wastewater treatment plants.

The civil engineering aspects of high-rise buildings, power plants, and industrial, military, and space-age facilities require the expertise of trained engineers. Advanced training can also lead to careers in teaching and research.

Because of the broad spectrum of the civil engineer's activities, the curriculum of the Department of Civil Engineering is based on a wide range of general scientific and engineering principles. The fundamental base is subsequently expanded into specialized subjects to give students a comprehensive, well-grounded training in the functions and responsibilities of the civil engineer.

COURSE OF STUDY FOR CIVIL ENGINEERING
(Bachelor of Science in Engineering)

Freshman Year

Fall Semester		
25-101	Intro. to Eng. Des.	2
42-101	College Writing I	3
84-121	Chemistry I*	3
84-123	Chemistry Lab	1
92-131	Calculus I*	4
95-141	Physics I*	3
96-141	Fund. Exp. Phys. I	1
39-	Physical Ed.	1
		18

Spring Semester		
25-127	Comp. Prog. for Engrs.	2
42-102	College Writing II	3
84-122	Chemistry II*	3
84-124	Chemistry Lab	1
92-132	Calculus II*	4
95-144	Physics II*	3
96-144	Fund. Exp. Phys. II	1
39-	Physical Ed.	1
		18

Sophomore Year

Fall Semester		
14-203	Statics	3
14-225	Surveying I	3
92-231	Calculus III*	4
	Area I or II Elective	3
	Area I or II Elective	3
		16

Spring Semester		
14-204	Strength of Materials	3
14-226	Surveying II	3
42-225	Tech. & Sci. Commun.	3
92-234	Differential Equations	3
92-386	Statistics for Sc.& Engr.	3
		15

Junior Year

Fall Semester		
14-305	Dynamics	3
14-310	Engineering Materials	3
14-350	Structural Analysis I	3
14-372	Civil Eng. Systems	3
64-201	Economics	3
	Area I or II Elective	3
		18

Spring Semester		
14-301	Fluid Mechanics	3
14-330	Soil Mechanics	3
14-340	Transportation Engr.	4
14-352	Reinforced Concrete	3
14-362	Sanitary Eng. I	3
		16

Senior Year

Fall Semester		
14-431	Found. & Soil Engr.	3
14-452	Steel Design	3
14-460	Water Resources Engr.	3
14-	Civil Engineering Elective**	3
22-347	Elem.Therm.& Heat Tran.	3
	Area I or II Elective	3
		18

Spring Semester		
14-402	Laboratory Practicum	2
14-461	Water Resources Designs	3
14-470	Civil Engineering Economics	3
14-	Civil Engr. Elective**	3
16-211	Fund. of Electricity	3
	Area I or II Elective	3
		17

* Appropriate honors courses may be substituted.

** ROTC or Civil Engineering elective.

The Five Year BS Engineering/MS Engineering Program

The purpose of this program is to offer qualified undergraduate students an accelerated program of study whereby a Master of Science in Civil Engineering may be awarded at the end of five years of study. The student benefits from the efficiency of a continuous, coordinated sequence of courses with reduced credit hour requirements. Assuming that all relevant requirements are met, the student will receive the B.S. in Engineering at the end of the fourth year and the M.S. in Engineering at the end of the fifth year.

General Requirements

A minimum grade point average of 3.0 is required for admission into the five-year Civil Engineering graduate program. A student with an average between 2.75 to 3.0 may be admitted provisionally with departmental approval. The grades of the student's first five semesters will be used to determine the grade point average.

Applicants who satisfy the Graduate School and Civil Engineering Department admission requirements for the five year program will be assigned a graduate faculty member who will act as their program advisor. The M.S.Eng. degree requires the successful completion of a minimum of 30 credit hours. These 30 hours include at least 24 hours in class and seminar study, of which at least 18 hours must be at the 500 level or higher. Also, at least 6 credit hours must be completed in preparation of a publishable thesis. Courses at the 400 level are designed for seniors, but under certain circumstances may be taken by graduate students for graduate credit. The student must file a special petition form, obtainable from the Graduate School, at the time of registration for the 400 level courses.

Special Requirements

A student seeking a five year M.S.Eng. may undertake a general civil engineering program or may choose an area of specialized study. These areas include environmental engineering, geotechnical engineering, structural engineering, transportation engineering, and water resources. The student who specializes must take at least four electives in the area of specialization or in an associated area approved by his/her program advisor.

Program of Study

All students must complete the following eight courses. It is recommended that they take at least two of them per term during the fourth and fifth years. The sequence of the required courses will be determined by the student and his/her advisor, considering the student's overall plan of study.

Required Courses

Fall Semester		Spring Semester	
14-431 Foundation & Soil Engr.	3	14-402 Laboratory Practicum	2
14-452 Steel Design	3	14-470 Engineering Economics	3
14-460 Water Resources Engr.	3	14-461 Water Resources Designs*	3
22-347 Elem. Therm. & Heat Trans.	3	16-211 Fund. of Electricity	3
	12		11

In addition to the required courses, eight electives must be taken, at least six of which must be at the 500 level or above. These courses may be taken in civil engineering or in an associated area approved by the student's advisor. The program for the fourth and fifth years is:

Fourth Year

Fall Semester		Spring Semester	
2 Required Courses	6	2 Required Courses	5 or 6
Area I or II Elective	3	Area I or II Elective	3
2 Civil Engr. Electives	6	2 Civil Engr. Electives	6
	15 hrs		14 or 15 hrs

* Course with fall term prerequisite.

Fifth Year

Fall Semester		Spring Semester	
2 Required Courses	6	2 Required Courses	5 or 6
2 Civil Engr. Electives	6	2 Civil Engr. Electives	6
Thesis	3	Thesis	3
	15 hrs		14 or 15 hrs

Under exceptional circumstances, a student who wishes to terminate his/her plan of study before the completion of the fifth year may be allowed to do so. In order to obtain a BSE, however, he/she must complete sucessfully the eight required courses, two Area I or II electives, and the two civil engineering electives which are part of this program.

Civil Engineering (Course Prefix: 14)

14-203 STATICS **I(3-0)3**
Vector concepts of forces and moments of forces. Static equilibrium of particles, rigid bodies, and simple structures. Static friction forces. Geometric properties of sections. Prerequisites: 92-132 or 92-134,95-144,96-144.

14-204 STRENGTH OF MATERIALS **II(3-0)3**
The concept of stress and strain at a point. Stress temperature relationships. Force and deformation analyses of bodies under axial, shearing, flexural, torsional, and combined loadings. Shear and bending moment diagrams. Euler Columns. Prerequisites: 14-203.

14-217 STATICS AND MECHANICS OF MATERIALS **I(3,0)3**
(Primarily for Chemical Engineering Students). Vector concepts of forces and moments, center of gravity and moment of inertia, equilibrium of simple structures. Friction, internal forces, stresses, and strains. Torsion, shear, and bending moment stresses. Deflections. Combined loadings and Mohr's Circle. Columns. Prerequisites: 92-132 or 92-134,95-141.

14-218 ANALYTICAL MECHANICS AND MATERIALS **I,II(4,0)**
Statics of particles and rigid bodies. Stress and strain, equilibrium, compatability, and transformations. Hooke's law. Stress in beams, columns, and torsional members. Elastic deflection of beams. Statically indeterminate problems. Concept of stability. (Primarily for Chemical and Plastic Engineering students.)

14-225 SURVEYING I **I(2,3)3**
A presentation of the basic instruments and equipment commonly used in survey processes such as distance, angle, and level measurements. The principles of closed and open traverses and their relationship to engineering projects such as land surveys and design projects. Fieldwork in the more elementary operations with a view toward acquiring sound basic skills. Office-type projects in contour drawing and the application of contoured topography to highway and water-control projects. Emphasis is placed on presenting data in forms common to present practice in the civil engineering profession. Prerequisites: 92-131 or 92-133,25-101,25-127.

14-226 SURVEYING II **II(2,3)3**
Classroom recitations related to the principles and practice of route surveys and designs. Topics include simple and compound circular curves, intersections of straight and curved baselines, vertical alignment principles including parabolic easement curves, earthwork operations and determination of volumes, and practice of construction surveying. Laboratory work includes office-type projects illustrative of the application of surveying information and civil engineering projects such as water resources, sanitary sewers, and property subdivision. Detailed fieldwork instruction in basic traverse surveys, gathering

of topographic information, and the staking-out of buildings and circular curves. Prerequisite: 14-225.

14-301 FLUID MECHANICS **II(3,0)3**
Fluid properties, fluid statics, and fluid dynamics including continuity, impulse-momentum, and energy equations. Pipe flow, turbomachinery, similitude, and modeling. Emphasis will be on incompressible fluids. Prerequisite: 14-203,92-234.

14-305 DYNAMICS **I(3-0)3**
Vector development of kinematics of a particle with respect to fixed and moving coordinate systems of one, two, and three dimensions. The dynamics of a particle, systems of particles, and rigid bodies. Angular momentum and the inertial properties of rigid bodies. Energy, impulse, and momentum. Prerequisites: 92-231,14-203.

14-310 ENGINEERING MATERIALS **I(2-3)3**
A treatment of the properties of engineering materials which influence the design, construction, and maintenance of civil engineering works. Included are such materials as ferrous and non-ferrous metals, timber, plastics, and cementitious materials. Description and identification of soils. Laboratory testing of various engineering materials. Prerequisites: 84-122,14-204.

14-330 SOIL MECHANICS **I(3-0)3**
Development of the fundamental principles of the science of soil mechanics as utilized in soil and foundation engineering. Includes index properties, classification, strength and deformation properties, and hydraulic properties which are required for foundation and soil engineering design. Prerequisites: 14-204,14-310.

14-340 TRANSPORTATION ENGINEERING **II(3-3)4**
Development of the basic principles pertaining to the movement of people and goods by modern transportation systems. Techno-economic characteristics of the various transportation modes. Aspects of planning, design and operation of land, air, and water transportation facilities. Development, structure, and function of the U.S. transportation system. Prerequisite: 14-225.

14-350 STRUCTURAL ANALYSIS I **I(2-2)3**
Principles of structural analysis applied to typical civil engineering projects as the initial step in the total design concept. Basic emphasis on the analysis of statically determinate structures with elements of modern methods of analysis of indeterminate structures. The digital computer as an analytical tool. Prerequisite: 14-204.

14-352 REINFORCED CONCRETE DESIGN **II(2-2)3**
Ultimate strength and elastic behavior of reinforced concrete structural members, continuity in building frames, deflections, shear reinforcement, development length and bar cutoffs, columns, and footings. Prerequisites: 14-310,14-350.

14-362 SANITARY ENGINEERING I **I(3-0)3**
Physical, chemical, and biological principles of the treatment of water and sewage are considered as well as their application to treatment systems. The several system components of water and sewage treatment plants are studied to provide a basis for design capability. Prerequisite: junior status.

14-372 CIVIL ENGINEERING SYSTEMS **I(3-0)3**
Introduction to methods of operations research, management science, and economic analysis used in the design, planning, and managing of engineering systems. Main topics include systems modeling, optimization concepts, network analysis, mathematical programming,

critical path analysis, decision analysis, and economic considerations. Prerequisite: junior status.

14-402 LABORATORY PRACTICUM **II(1,3)2**
Laboratory exercises in the testing of structural and highway materials, environmental analysis, hydraulic experiments, and transportation field studies. Prerequisite: senior standing.

14-431 FOUNDATION AND SOIL ENGINEERING **II(3-0)3**
The application of soil mechanics to the design and analysis of foundations and soil structures. Includes slope stability analysis and the design of retaining structures, deep and shallow foundations, and the bracing of excavations. Introduction to soil mechanics laboratory practice. Prerequisite: 14-330.

14-441 TRAFFIC ENGINEERING **II(2-3)3**
Traffic flow, human, and vehicular characteristics. Volume, speed, travel time, and delay studies. Roadway and intersection capacity. Traffic control methods and devices. Street and freeway operations. Accidents and safety. Parking studies. Environmental and energy impacts. Prerequisite: 14-340.

14-450 STRUCTURAL ANALYSIS II **II(3-0)3**
Classical and matrix methods of structural analysis applied to complex plane trusses. Elementary space truss analysis. Elementary model analysis through the use of influence lines for indeterminate structures. Use of the digital computer and problem oriented languages as analytical tools. Prerequisite: 14-350.

14-452 STEEL DESIGN **I(2-2)3**
An elementary introduction of structural steel design with emphasis on use and interpretation of the *AISC Manual and Specifications*. Subjects include design of tension, compression, beams, and beam-column members, plus bolted and welded connections. Other topics may include composite beams, plate girders, building connections, and plastic analysis and design. Prerequisite: 14-350.

14-456 ADVANCED STRUCTURAL DESIGN **II(2-2)3**
A study of the design and construction of modern structures for students majoring in structural engineering. Emphasis is placed on special projects, case studies, and the use of the digital computer. Special topics include torsion of non-circular members, prestressed concrete, beam-columns, design of flat slabs, and elementary earthquake design. Prerequisites: 14-352,14-452.

14-460 WATER RESOURCES ENGINEERING **I(3-0)3**
Elements of classical hydrology including precipitation, runoff, abstractions, groundwater, hydrographs, and statistics in hydrology. Open channel flow and water law. Prerequisite: 14-301.

14-461 WATER RESOURCES DESIGNS **II(2-2)3**
A sequence of brief design projects selected from pumping stations, water transmission systems, distribution networks, sewers, culverts, drainage systems, waterhammer and surge, hydrologic analysis, water surface profiles, and flood routing. Computer methods are used. Prerequisite: 14-460.

14-463 SANITARY ENGINEERING II **II(3-0)3**
A study of the effects of waste discharges on the aquatic environment. Streams, lakes, and marine systems are considered. Modeling of effects are explored through use of the Streeter-Phelps equation and various modifications. Stream sampling techniques and data collec-

tion and analysis are stressed. Prerequisite: 14-362.

14-470 ENGINEERING ECONOMICS **II(3-0)3**
The analysis of economic effects of engineering decisions. Emphasis on the allocation of limited financial resources among competing investment alternatives. Economic evaluation of plans, programs, and projects using methods of present worth, annual cash flow, (internal) rate of return, benefit-cost ratio, and incremental analysis. Depreciation methods and their effects on after-tax cash flows. Replacement analysis for retirement of assets and alternatives for the future. Prerequisite: 64-201.

14-475 CONSTRUCTION MANAGEMEMT **I(3-0)3**
Development of management skills and techniques to plan, schedule, supervise, and control construction projects. Project estimating; labor costs and productivity; construction plans, specifications and contracts; labor relations; time, cost and quality control; construction equipment and project decision making and financing. Prerequisite: permission of instructor.

14-480 to 14-483 SELECTED TOPICS **I, II(3-0)3**
Contemporary topics in selected areas of study within civil engineering. Course content will be varied by the instructor to meet the interests of the students.

Primarily for Graduate Students, but may be used as civil engineering electives with permission of the instructor and the academic advisor.

14-504 ADVANCED STRENGTH OF MATERIALS **(3-0)3**
Stress and strain at a point; curved beam theory, unsymmetrical bending, shear center, torsion of non-circular sections; theories of failure; introduction to the theory of elasticity.

14-533 ADVANCED FOUNDATION ENGINEERING **(3,0)3**
Design and analysis of shallow and deep foundations for various types of soil profiles are studied. Foundations contiguous to existing structures are also investigated.

14-536 SOIL ENGINEERING **(3-0)3**
The study of soil as an engineering material, and its use in earth dams, road embankments, and compacted fills. Stability of natural slopes is also examined.

14-540 URBAN TRANSPORTATION PLANNING **(3-0)3**
Basic principles of urban transportation planning to include characteristics of urban travel and urban transportation systems. Data collection for transportation planning. Analysis of urban travel demand and analysis of transportation system performance. Transportation project evaluation and project implementation.

14-543 TRANSPORTATION SYSTEMS ANALYSIS **(3-0)3**
Demand, supply, and equilibrium in multimodal transportation systems. Analysis of transportation demand, transportation technologies, and performance functions. Consequences of transportation decisions, searching for optimal design strategies.

14-553 TIMBER STRUCTURES (3-0)3
Design of timber members in tension, compression, and bending. Design of connections, laminated wood trusses, and frames.

14-561 PHYSICAL CHEMICAL TREATMENT PROCESSES (3-0)3
Theories of physical chemical treatment processes and the laboratory (or pilot plant) techniques necessary to obtain design. Treatment processes for natural waters, domestic wastes, and industrial wastes. Development of design methods and the relationship of these processes to environmental quality.

14-562 GROUNDWATER HYDROLOGY (3-0)3
Description and analysis of the occurrence and movement of groundwaters. Evaluation of aquifers, aquifer development, and sampling. Examination of field problems such as pollution and salt water intrusion.

14-565 INDUSTRIAL WASTE TREATMENT PROCESSES (3-0)3
An introduction to the unit operations most commonly encountered in industrial waste treatment. Specific industrial applications will be stressed after an understanding of each unit operation has been developed.

14-567 ENVIRONMENTAL CHEMISTRY I (3-0)3
The chemistry of natural waters and of water and wastewater treatment. Dilute aqueous solution chemistry of acid-base reactions and complex formation. Emphasizes chemical equilibrium. Foundation for environmental studies.

14-568 ENVIRONMENTAL CHEMISTRY APPLICATIONS (3-3)3
Chemical analysis of natural and polluted water. Lecture and laboratory projects to develop analytical techniques and knowledge of water treatment technology.

14-570 SMALL AND ALTERNATIVE WASTE WATER TREATMENT (3-0)3
A design-oriented course covering subsurface disposal, surface systems disposal, nonconventional collection systems, and planning approaches.

DEPARTMENT OF ELECTRICAL ENGINEERING

Sidney A. Bowhill, Department Chairman

Professors: Roger H. Baumann, F. Ross Holmstrom, Dikshitulu Kalluri, Alexander Khazan, Venkatarama Krishnan, E. Russell Laste, James E. Powers, Bodo W. Reinisch

Associate Professors: Francesco L. Bacchialoni, Ronald D. Brunelle, George P. Cheney, Donn A. Clark, Robert J. Dirkman, Walter S. Kuklinski, J. Robert A. Lemieux, John P. Leonard, Harry E. Moses, Paul J. Murphy, Robert E. Parkin, Martin A. Patt, Kanti Prasad, H. James Rome, Ziyad Salameh, Gary S. Sales, Stephen J. Spurk, Anh Tran, David P. Wade, Fahd G. Wakim, A. David Wunsch

Assistant Professors: Michael J. Barrett, Chris J. Georgopoulos, Charles W. Jim, Craig G. Prohazka, Tenneti C.K. Rao, Mahmoud Wagdy, Jay A. Weitzen

Visiting Professor: Byron Dennison

Electrical engineering is a dynamic field, receiving much of its stimulus from contemporary breakthroughs in the pure sciences. Because engineering disciplines continuously incorporate new concepts and developments, a viable engineering education cannot be limited to the acquisition of specific skills and methods, but also must include understanding of both the current and the emerging engineering field.

Accordingly, the electrical engineering curriculum provides a thorough grounding in electrical science, engineering, and mathematics, and emphasizes the techniques of experimental science and technology through investigative laboratory work and classroom lecture-demonstrations. Specialization at the undergraduate level is currently limited to the concentration in microwave engineering.

Interdisciplinary study is fostered through the selection of technical electives.

An important aspect of the electrical engineering curriculum is the technical elective program of the senior year. Technical electives provide opportunities for broadening technical knowledge in a flexible manner and in accordance with student interests and competencies.

A significant portion of the curriculum is devoted to studies in the humanities and social sciences. Considerable choice of subjects is allowed. These subjects broaden a student's outlook and serve to focus attention on the importance of nontechnical knowledge in examining a professional career.

Because the number of students seeking to enter electrical engineering in the sophomore year exceeds the capacity of the department to accommodate them, priority will be given to those who have completed all of the required freshman courses and who exceed the grade point requirements established by the department.

COURSE OF STUDY FOR ELECTRICAL ENGINEERING (Bachelor of Science in Engineering)

Freshman Year

Fall Semester			Spring Semester		
25-101	Intro. Graph. Des.	2	25-127	FORTRAN	2
42-101	English I	3	42-102	English II	3
84-121	Chemistry I	3	84-122	Chemistry II	3
84-123	Chemistry Lab I	1	84-124	Chemistry Lab II	1
92-131/3	Calculus I	4	92-132/4	Calculus II	4
95-141	Physics I	3	95-144	Physics II	3
96-141	Physics Lab I	1	96-144	Physics Lab II	1
39-001	Physical Ed.	1	39-002	Physical Ed.	1
		18			18

Sophomore Year

Fall Semester			Spring Semester		
16-201	Circuit Theory I	4	16-202	Circuit Theory II	4
16-207	Basic E.E. Lab I	2(1ED)	16-208	Basic E.E. Lab II	2(1ED)
64-201	Economics I	3	16-217	Minicomp. Oper. & Prog.	4(2ED)
92-231/3	Calculus III	4		or	
95-245	Physics III	3	16-265	Logic Design	4(2ED)
96-245	Physics Lab III	1	64-202	Economics II	3
			92-234	Differential Equations	3
		17			16

Junior Year

Fall Semester		Spring Semester	
16-265 Logic Design	4(2ED)	16-312 Electronics Lab II	2(1ED)
or		16-362 Signals and Systems	3
16-217 Minicom. Oper. & Prog.	4(2ED)	or	
16-311 Electronics Lab I	2(1ED)	16-355 Electromechanics	3
16-315 Complex Variables	3	16-360 Electromagnetic Theory I	3
16-355 Electromechanics	3	16-366 Electronics II	3(1.5ED)
or		Area I or II	3
16-362 Signals & Systems	3	22-214 Mechanics	4
16-365 Electronics I	3		
Area I or II	3		
	18		18

Senior Year

Fall Semester		Spring Semester	
16-413 Linear Feedback Systems	3(1.5ED)	Technical Elective	3(3ED)
or		or	
Technical Elective	3(1.5ED)	16-413 Linear Feedback Systems	3
16-461 Electromagnetic Theory II	3	Technical Elective	3(ED)
Area I or II	3	Technical Elective	3
Free Elective	3	Area I or II	3
22-347 Thermodynamics	3	Free Elective	3
	15		15

Total credits = 135

Notes:

1. In addition to specified prerequisites listed in the course description, the following general prerequisite requirements apply: 16-201, Circuit Theory I, is prerequisite to all EE courses numbered 16-202 and higher, and is corequisite for 16-207. 16-202, Circuit Theory II, is prerequisite to all EE courses numbered 16-311 or higher, and is a corequisite for 16-208, 16-217, and 16-265.
2. 16-360, Electromagnetic Theory I is normally taken spring semester of the junior year. Enrollment in this course in the fall and 16-461, Electromagnetic Theory II, in the spring of the junior year may be restricted to students in the microwave engineering program.
3. EE students must take two elective courses from area II, and two more elective courses from areas I or II. To assure compliance with ABET requirements on course content, students should consult the humanities and social science guidelines published by the College of Engineering. Completion of area I & II electives plus Economics I & II fulfills the University area distribution requirements and ABET humanities and social science requirements.
4. Students must select at least one of their area I or II elective courses from the University list of approved human values courses.
5. Students must generate six Engineering Design (ED) units from senior year electives to yield the total of 18 ED units required in the BSEE program.
6. Seniors may substitute one course offered by another department for an EE technical elective provided the course meets the technical and analytical requirements established for EE students. This course must be offered at a level that is higher than the highest level required course for EE majors in the same area. Since department policies may impose further limits on the choice of electives, students must consult with their advisor prior to registration.

Five Year BSEE/MSEE Combined Program

To encourage outstanding undergraduate students to continue study toward an advanced degree, the Electrical Engineering Department offers an accelerated program. When the requirements of the department and of the Graduate School are met, the student will receive the BSEE at the end of the fourth year and the MSEE at the end of the fifth year. To complete the work for both degrees within five years, *the student must make a commitment to the program prior to the beginning of the junior year.*

A principal benefit of the early identification of academic goals by the student and advisor is a careful structuring of course work that permits the scheduling of prerequisite and required courses in sequence, thus effecting a considerable saving of time.

1. The commitment to the BSEE/MSEE program must be made prior to the fall semester of the junior year. Students accepted into the program are not required to take Graduate Record Examinations.
2. Summer course work is not required, although the option of summer school is available.
3. With prior approval, the student may take six semester credits of graduate work at another accredited institution. Transfer credit will be allowed for those courses in which the earned grade is a B (3.00 on a 4.00 scale) or better.

The following courses of study are required for undergraduates admitted to the B.S./M.S. Eng. program. A technical elective should be taken in the Spring semester of the junior year in place of a humanistic-social elective. A proposal must be ready for review at the start of the Fall term of the graduate year. A suggested course of study for thesis students for their senior and graduate years is:

Senior Year

Fall Semester		Spring Semester	
16-461 Electromagnetic Theory II	3	16-413 Linear Feedback Systems	3
22-347 Elements of Thermodynamics and Heat Transfer	3	H/S Elective	3
H/S Elective	3	H/S Elective	3
Graduate Course 1	3	Graduate Course 3	3
Graduate Course 2	3	Graduate Course 4	3
	15		15

Graduate Year

Fall Semester		Spring Semester	
Graduate Course 5	3	Graduate Course 6	3
Graduate Course 7	3	Graduate Course 8	3
Thesis	3	Thesis	3
Technical Elective	3	Technical Elective	3
	12		12

Graduate Year (non-thesis option)

Fall Semester		Spring Semester	
Graduate Course 5	3	Graduate Course 8	3
Graduate Course 6	3	Graduate Course 9	3
Graduate Course 7	3	Graduate Course 10	3
Graduate Seminar	3	Technical Elective	3
Technical Elective	3		
	15		12

An advantage of enrolling in the combined B.S./M.S. Eng. program is that two graduate courses are substituted for the two free electives taken in the senior year. These two graduate courses are credited towards the master's degree, thus reducing the total course load for B.S./M.S. students by six credit hours. The courses of study followed during the junior and senior years must have the approval of the student's academic advisor and must satisfy all of the requirements for the B.S. degree. The graduate coordinator will ensure that the requirements for the M.S. degree are fulfilled by approving the courses of graduate study.

Electrical Engineering (Course Prefix: 16)

Undergraduate Courses

16-201 CIRCUIT THEORY I **I(4-0)4**

Terminal characteristics of ideal elements, active and passive. Ohm's Law and Kirchhoff's Laws. Introduction to network topology, independent variables, loop and nodal analysis. Definition and consequences of linearity, superposition theorem. Concept of excitation and response. Passive equivalent circuits, active equivalent circuits, Thevenin's and Norton's theorems. Ideal inductance and capacitance, volt-ampere characteristics, energy relations, graphical differentiation, and integration. First-order transients, initial conditions, natural response and natural frequencies. Network response to unit step function and unit impulse. Second-order transients: RLC circuits, natural frequencies and the complex-frequency s-plane. Only open to students accepted as sophomore—level EE majors. Prerequisite: 92-132 or 92-134 and 95-144. Corequisites: 16-207 and 95-245.

16-202 CIRCUIT THEORY II **II(4-0)4**

Sinusoidal forcing function, complex numbers, phasors, sinusoidal steady-state. Average real power, reactive power, and rms values. Exponential forcing function, poles and zeros in the s-plane, concept of the system function and its use in determining the forced response and natural behavior of circuits. Frequency response and resonance, reactance cancellation and concept of s-plane vectors. Thevenin's and Norton's theorems, superposition, reciprocity, and maximum power in the frequency domain. Magnetic coupling, mutual inductance, ideal transformer. Impedance and admittance and hybrid parameters for a two-port network. Introduction to matrices and their use in circuit analysis. General response by pre-box techniques. Prerequisite: 16-201. Corequisite: 16-208.

16-207 BASIC ELECTRICAL ENGINEERING LABORATORY **I(1-3)2**

Experimental work designed to verify theory and to acquaint students with electrical measurement techniques: experiments on dc meters, bridges, and oscilloscopes. Remainder of experiments are correlated with course 16-201 and concern: resistive measurements, Kirchhoff's Laws, network theorems, conservation of power and maximum power transfer, inductance and capacitance, and first and second-order transients. **50% Engineering Design.** Corequisite: 16-201.

16-208 BASIC ELECTRICAL ENGINEERING LABORATORY II **II(1-3)2**

Experimental work, designed to emphasize electrical measurement techniques of linear-systems with time-varying signals. Wave-form measurements with dc and ac meters as well as advanced use of the oscilloscope with experiments integrated with course 16-202. Experiments concern: Kirchhoff's laws for phasors, magnitude and phase measurements of impedance, network theorems, frequency response, resonance, inductance and transformers, and maximum power transfer. **50 % Engineering Design.** Prerequisite: 16-207. Corequisite: 16-202.

16-211 FUNDAMENTALS OF ELECTRICITY **I,II(3-0)3**

An introduction to the basic principles of electricity, including the concepts of voltage, current resistance, inductance, capacitance, energy, and power; Ohm's and Kirchhoff's Laws; Thevenin's and Norton's Theorem's; RC and RL transient analysis; the concept of average and root mean square values; and the analysis of steady state alternating current circuits including complex impedance and phasor notation. Prerequisite: 92-132 or 92-134, and 95-144. Not open to students majoring in electrical engineering.

16-217 MINICOMPUTER OPERATIONS AND PROGRAMMING **I,II(3-3)4**

The study of a typical minicomputer and the control of its functional components through software programming. Solutions to the assigned problems are designed by developing a flowchart of the solution algorithm and coding it either directly in machine language or through the use of an assembler. The problems assigned comprise a set of software tools that are used in the design of solutions to other problems. Particular emphasis is placed on developing user written I/O routines, and each student is provided with a separate system for developing and testing design solutions. **50% Engineering Design.** Prerequisite: 25-127. Corequisite: 16-202.

16-265 LOGIC DESIGN **I,II(3-3)4**

Design of combinatorial and sequential binary networks taught from the engineering viewpoint. Simple binary gates such as AND, OR, NAND, NOR, and their interconnection in logic circuits. Boolean Algebra. Algebraic, graphical, and logical circuit minimization techniques. Design of complex digital circuits such as multiplexers, adders, decoders. Flip-flops and clocked sequential circuits such as shift registers and counters. State assignments and state reduction. Design of a simple digital computer incorporating general registers, common addressing modes, and conditional instructions. This is an experiment-oriented course. Theories learned in the lectures are applied to the design and building of circuits through laboratory experiments. **50% Engineering Design.** Prerequisite: 16-201. Corequisite: 16-202.

16-267 LOGIC DESIGN **I,II(3-3)4**

A course similar to 16-265 for computer science and other non-EE majors. Prerequisite: 95-142.

16-311 ELECTRONICS LABORATORY I **I(1-3)2**

A laboratory course with experiments coordinated with the subject matter of 16-365. Characteristics and use of electronic instrumentation for making measurements of electronic circuits. Methods of designing and characterizing diode and transistor circuits. Analysis of performance characteristics of digital and linear semiconductor circuits, including logic elements and amplifiers. Design and construction of circuits using monolithic op amps. **50% Engineering Design.** Corequisite: 16-365.

16-312 ELECTRONICS LABORATORY II **II(1-3)2**

A laboratory course with experiments coordinated with the subject matter of 16-366. High-frequency characteristics of transistors and transistor amplifiers. Feedback in electronic circuits. Electronic oscillators. Differential amplifiers. Properties of linear IC operational amplifiers, and their application in amplifier circuits and waveform generation circuits. Digital and linear circuit design and analysis. Design of a complete electronic system. **50% Engineering Design.** Prerequisite: 16-311. Corequisite: 16-366.

16-315 COMPLEX VARIABLES FOR ENGINEERS **I(3-0)3**

Complex variables with emphasis on electrical engineering applications. Analytic functions, Cauchy-Riemann conditions. Line integrals, Cauchy's integral formula and residues. Singularities. Taylor and Laurent series. Principle of the argument, Laplace Transforms, Bromwich Integral, Nyquist's Criterion, stability. Prerequisite: 92-234 and 16-202.

16-355 INTRODUCTORY ELECTROMECHANICS **I,II(3-0)3**

Magnetic circuits. DC machines. Singly and multiply excited systems. Three-phase synchronous generators and motors. Tranformer equivalent circuit, the autotransformer, three-phase connections. Three-phase induction motor, single-phase motors. Prerequisites: 16-202 and 95-245.

16-360 ELECTROMAGNETIC THEORY I **I,II(3-0)3**

An intermediate course in electrostatics and magnetostatics using vector calculus. Topics include: the electric field, line and surface integrals, potential, the divergence theorem, Gauss' law, capacitance, conductors, dielectrics. Poisson's and Laplace's equations, the Biot-Savart law, Stokes' theorem, scalar and vector magnetic potentials, force and torque on conductors, magnetic circuits and inductance. Prerequisite: 92-234 and 16-202.

16-362 SIGNALS AND SYSTEMS **I,II(3-0)3**

Introduction to signals and systems. Signal classification: continuous vs. discrete; analog vs. quantized; deterministic vs. random. Normalized energy and power. Signal families, complex exponential, step impulse. Sequence representation of digital signals. Systems: time-domain representation by differential equations; linear time-invariance; classical solution to various signal families; frequency domain representation by system function H(s); total solution of system with initial conditions using H(s). Block-diagram representation of systems and differential equations. Impulse and pulse response of LTI systems. Convolution methods: properties, scanning with impulses, convolution algebra. Fourier series analysis of systems with periodic inputs, properties, spectra, and series development with impulse method. Fourier transforms: properties, energy and power signals, response of ideal and non-ideal filters. Nyquist's sampling theorem and its application to conversion between discrete and continuous signals. Laplace transforms, properties and use, inversion by partial fractions, residues with s-plane vectors, application of LTI systems with initial conditions and sources. Introduction to digital elements and equations. First and second order recursion equations and corresponding digital system block diagrams. Brief survey of digital simulation, Z-transforms and digital filtering. Prerequisites: 92-234 and 16-202.

16-365 ELECTRONICS I **I(3-0)3**

A brief introduction to solid-state physics, leading to discussion of physical characteristics of pn junction diodes, bipolar junction transistors, and field-effect transistors. Circuit models for diodes, and diode applications. Circuit models for transistors, and transistor applications in digital circuits and low-frequency amplifier circuits. Analysis of digital circuits and linear circuits based on application of circuit models of devices and circuit theory. Introduction to computer-aided analysis and modelling of electronic circuits using SPICE. Prerequisite: 84-122,16-202. Corequisite: 16-311.

16-366 ELECTRONICS II **II(3-0)3**

A continuation of 16-365 with discussion of multi-transistor amplifiers at high frequencies; small- and large-signal amplifiers; and feedback amplifiers and oscillators. Circuit design employing integrated circuits and discrete electronic device. Circuit analysis using FORTRAN programming and SPICE. An electronic design project is included in the course. **50%** Engineering Design. Prerequisite: 16-365. Corequisite: 16-312.

16-371 MICROPROCESSOR APPLICATIONS LAB **I,II(2-3)3**

Laboratory course with accompanying lecture involving microprocessor programming and interfacing techniques. Topics include hexidecimal numbers, microprocessor instruction sets, arithmetic and logic operations, branching, arrays and stacks, subroutines, interrupts, address decoding, interfacing memory, data output and input, use of the peripheral interface adapter, digital-to-analog and analog-to-digital conversion, interfacing to signal sources, and loads such as shaft encoders and stepper motors. **50% Engineering Design.** Prerequisite:16-217 or 91-203, and 16-265 or 16-267.

16-401 DIGITAL SIGNAL PROCESSING I,II(3-0)3
Discrete-time signals and systems, definitions, linear shift invariant systems linear difference equations, time-domain analysis. Sampling, linear convolution. Frequency-domain analysis of discrete-time systems, the Z-transform, discrete Fourier series and transform; the FFT. Computer-aided design of digital filters. Quantization effects. Applications. **50% Engineering Design.** Prerequisite: 16-362.

16-403 MICROWAVE DESIGN THEORY I,II(3-0)3
An introductory course in the analysis and design of passive microwave devices, beginning with a review of time-varying electromagnetic field concepts and transmission lines. Smith Chart problems; single and double stub matching; impedance transformer design; maximally flat and Chebyshv transformers; microwave transmission lines, slotted lines, coplanar lines; rectangular and circular waveguides; waveguide and their use in impedance matching; design of directional couplers; features of weak and strong coupling microwave filter design; characteristics of low-pass, high-pass, band-pass, band-stop filter designs; 2-port network representation of junctions; Z and Y parameters, ABCD parameters, scattering matrix; microwave measurements; measurement of VSWR, complex impedance, dielectric constant, attenuation, and power. **50% Engineering Design.** Prerequisite: 16-461.

16-408 through 16-410 PROJECT LABORATORY I,II(0-4)3
The purpose of this course is to provide an opportunity for qualified electrical engineering students to investigate specific areas of interest. The actual project undertaken may be software or hardware oriented, or involve library research, or some combination. The most important characteristics of the projects are that the end results represent independent study, that they are research and development oriented, and that they are accomplished in an engineering environment. Design reviews, progress reports, and a final formal report are expected for each project. **100% Engineering Design.** Prerequisite: permission of instructor.

16-411 LOGIC DESIGN OF DIGITAL SYSTEMS I I(3-0)3
A review of number systems and base conversion. An introduction to Boolean algebraic and combinatorial logic concepts. Minimization techniques including Boolean algebraic manipulation, the Karnaugh map method, and the Quine-McCluskey tabluar method. Simplification techniques are applied to multiple output networks and incompletely specified functions. Error detection and correction codes. Code conversion, read-only memory (ROM), multiplexers, and programmed logic arrays (PLA). An introduction to sequential machines, including state table, state diagram, and minimization concepts.

16-412 LOGIC DESIGN II I,II(3-0)3
Finite synchronous and asynchronous sequential machines. State diagrams, state tables, implication tables, and graphs are used to determine equivalent states, and therefore equivalent minimal sequential machines. State assignment and complete machine logic design. Hazards in combinational and sequential networks. Introduction to neural networks, Turing machines, and automata. **50% Engineering Design.** Prerequisite: 16-265.

16-413 LINEAR FEEDBACK SYSTEMS I,II(3-0)3
Concepts of open loop and closed loop feedback systems. Feedback in electrical and mechanical systems. Mathematical models of systems and linear approximations. Transfer functions of linear systems, block diagrams and signal flow graphs. Sensitivity, control of transient response, disturbance signals. Time domain performance involving steady state

errors and performance indices. Stability related to s-plane location of the roots of the characteristic equation. Routh-Hurwitz criterion. Graphical analysis techniques: root locus, frequency response as polar plot, and Bode diagrams. Closed loop frequency response. A control system design project is included in the course. **50% Engineering Design.** Prerequisite: 16-362.

16-416 ELECTRONIC AMPLIFIER CIRCUITS I,II(3-0)3
An integrated treatment of the analysis and design of electronic amplifiers. Typical amplifier specifications such as noise figure, intermodulation, intercept point, power dissipation, frequency response, gain compression point, and VSWR are discussed in detail. Emphasis is then placed on the choosing of electronic devices and circuit configuration based on amplifier and system design objectives. **50% Engineering Design.** A number of lab experiments are included in the course. Prerequisite: 16-366.

16-417 ABSOLUTE AND SYMBOLIC PROGRAMMING I,II(3-0)3
An introduction to machine and assembly language programming and coding fundamentals. Typical digital computer organization to include breakdown of function blocks including arithmetic unit, control unit, memory, and input-output structure. Computer word formats: single and double precision, floating point, and instruction words. Machine instructions and methods of execution. Symbolic coding. Address modification, index registers, and looping. Subroutines, calling sequences, and utility routines. Input-output programming. Table processing techniques. Programs will be run by students on DEC PDP-II minicomputers in the Electrical Engineering Department. Each student is expected to address a reasonably complete engineering design problem and demonstrate the operation of his or her program(s) on the PDP-11. This course is designed primarily for graduate students and is not open to students who have taken 16-217. **50% Engineering Design.** Prerequisite: 25-127.

16-420 COMPUTERS IN ENGINEERING ANALYSIS AND DESIGN II(3-0)3
An advanced programming course which considers the digital computer as a tool for solving significant engineering problems. The course is based on a specific area in engineering which will be selected from such topics as large scale circuit analysis, systems simulation, and optimization techniques. Stress is placed on the design and use of algorithms related to the specific topic studied. User-oriented programs or subroutine packages will be developed in a project. **100% Engineering Design.** Prerequisite: 25-127 and EE senior standing.

16-430 TELECOMMUNICATION SYSTEMS I,II(3-0)3
Special topics in telecommunication systems, with emphasis on satellite communications. Introduction to satellite link terminology and calculations which lead to an understanding of the specifications and engineering trade-offs in satellite-based communication system design. Topics: noise, temperature, EIRP of antenna, antenna gain, link budget, earth station G/T, baseband transmission, Nyquist filters, raised cosine filters, optimum one shot receiver, BPSK error performance, OPSK error performance, forward error correction. **50% Engineering Design.** Prerequisite: 16-362.

16-434 ACTIVE NETWORK THEORY II(3-0)3
A study of active inductorless networks with emphasis on design and implementation. The course will cover the following subjects: approximation theory, the operational amplifier, the gyrator, the negative impedance converter, analysis of basic second order active building blocks, the biquad building block, the state-variable filter, and the design of filters. The course will include a design project. **100% Engineering Design.** Prerequisite: 16-366.

16-435 SPECIAL TOPICS IN E.E.—ENGINEERING SCIENCE **I,II(3-0)3**
Advanced study of specialized theoretical and analytical topics in electrical engineering not included in other courses. Enrollment in specific sections may be limited to EE seniors. Prerequisites will vary with topics.

16-436 SPECIAL TOPICS IN E.E.—ENGINEERING DESIGN & SCIENCE **I,II(3-0)3**
Advanced study of specialized topics combining design and analysis in electrical engineering not included in other courses. Enrollment in specific sections may be limited to EE seniors. **50% Engineering Design.** Prerequisites will vary with topics.

16-437,16-438 SPECIAL TOPICS IN E.E.—ENGINEERING DESIGN **I,II(3-0)3**
Advanced study of specialized design oriented topics in electrical engineering not included in other courses. Enrollment in specific sections may be limited to EE seniors. **100% Engineering Design.** Prerequisites will vary with topics.

16-439 INTRODUCTION TO COMMUNICATIONS THEORY **I(3-0)3**
An introduction to the study of the time-domain and frequency domain characteristics of signals arising in communication systems. Fourier analysis, correlation functions, and power and energy density spectra. The time and frequency characteristics of thermal noise voltages. Amplitude modulation, frequency modulation, digital modulation. Signal-noise ratio, and noise figure. Prerequisite: 16-362.

16-440 COMMUNICATION SYSTEMS **II(3-0)3**
Analysis of the performance and operating characteristics of communication systems using probability theory. Concentration on digital systems. **50% Engineering Design.** Prerequisite: 16-362.

16-443 ELECTRICAL POWER SYSTEMS I **I(3-0)3**
An intermediate course in analysis and operation of electrical power systems, using mathematical techniques including calculus and matrix algebra. Topics include network reductions and representation of lines, generators, and transformers, network topology, and transform methods. Emphasis is placed on the bus impedance matrix and its corresponding rake equivalent circuit for use in power network problems. Symmetrical components are introduced with application to polyphase systems. Prerequisite: 16-355.

16-444 ELECTRICAL POWER SYSTEMS II **II(3-0)3**
A continuing use of symmetrical components and the rake equivalent circuit as further applied to the analysis of polyphase systems. Particular emphasis will be given to fault studies in three-phase systems. An introductory study, using selected numerical methods will be directed to load flow, economic dispatch, unit commitment, and system stability. Prerequisite: 16-443.

16-445 ANALOG DEVICES AND TECHNIQUES **I(3-0)3**
A survey of analog devices and techniques, concentrating on operational amplifier design and applications. Operational amplifier design is studied to reveal the limitations of real operational amplifiers, and to develop a basis for interpreting their specifications. Representative applications are covered, including amplifiers, differential and instrumentation amplifiers, summers, integrators, active filters, nonlinear circuits, and waveform generators. A design project comprises a major portion of the course. **100% Engineering Design.** Prerequisite: 16-366.

16-461 ELECTROMAGNETIC THEORY II **I,II(3-0)3**
Extension of 16-360 to time-varying fields. Topics include Faraday's law, displacement current, Maxwell's equations, plane waves, Poynting's theorem, skin depth, transmission line theory, and Smith chart. Prerequisite: 16-360

16-462 ANTENNA THEORY AND DESIGN **II(3-0)3**
An introduction to the properties of individual antennas and arrays of antennas. Retarded potentials, dipoles of arbitrary length, radiation pattern, gain, directivity, radiation resistance. The loop antenna. Effects of the earth and ionosphere. Reciprocity, receiving antennas, effective length and area. Arrays: colinear, broadside, endfire. Array synthesis. Mutual coupling. T.V. antennas, log periodic and Yagi arrays. Radiation from apertures, the waveguide horn antenna. Noise temperature. **50% Engineering Design.** Prerequisite: 16-461.

16-465 ROBOTICS **I,II(3-0)3**
A design-oriented introduction to robotics. The history of robotics; types of robots and their classification; methods of driving and sensing robot position; vector and matrix mechanics applied to robots; the inverse kinematic solution and motion of a robot end effector along an arbitrary trajectory; robot vision systems. A student project is required. **50% Engineering Design.** Prerequisite: 16-413.

16-466 MICROPROCESSOR DEVELOPMENT SYSTEMS **I,II(3-0)3**
A hardware-oriented course designed to acquaint students with the principles of simple microprocessor architecture as it is manifested in some of the more popular devices and chip families. The course will consider processor concepts, CPU hardware, and support chips and the software instruction sets. Focus will be on th Motorola MC-6800 family. There will be hands-on experience with microprocessor software development systems. Enrollment limited. **50% Engineering Design.** Prerequisites: 16-217,16-265.

16-467 TRANSDUCER DESIGN **I,II(3-0)3**
Introduction to electronic measurement and analyzing systems, the theory of transducing, various transducer structures, and the methods of transducer design, test, and application. **100% Engineering Design.** Prerequisites: 16-355,16-365.

16-468 ELECTRO-OPTIC SYSTEM DESIGN **I,II(3-0)3**
Analysis of electro-optic signal generation, transmission, and detection. Emphasis on optical fiber link data communications. **100% Engineering Design.** Prerequisites: 16-360,16-365.

16-469 VLSI DESIGN I **I,II(3-0)3**
Simulation and fabrication of MOS circuits and devices, and implementation of digital system design in MOS technology. Topics include a quantitative model of the MOS transistor; storage elements and sequential circuits; time delays and power dissipation; SPICE analysis of circuits and subsystems; MOS circuit fabrication processes; design rules; and circuit layout and optimization. Students will design circuits using CAD tools. **100% Engineering Design.** Prerequisites: 16-265,16-365.

16-470 VLSI DISIGN II **I,II(3-0)3**
Modeling of first- and second-order phenomena in MOS transistors applied to interconnection, time response, and power dissipation in MOS circuits. NMOS and CMOS circuit fabrication; design rules, layout, and yield; and restoring logic and pass logic. Implementation of data paths, control structures, and array structures such as decoders, ROMs, and PLAs. **100% Engineering Design.** Prerequisite: 16-469.

Primarily for Graduate Students

16-502 INTRODUCTION TO VLSI DESIGN **(2-3)3**
A study of MOS device electronics, circuit forms, and methodologies. Logic design techniques and system architectures. Lay out, fabrication, and patterning technology for integrated circuits. SPICE models. Laboratory exercises. Prerequisite: 16-365 or 16-574.

16-503 SOLID-STATE PHYSICAL ELECTRONICS I **(3-0)3**
Introduction to the behavior of solid state devices. Review of Bohr's model of the atom, wave-particle duality, wave packets, and Schroedinger's equation. Study of crystalline and amorphous materials. Band theory of solids, electrons, and holes. Metals, insulators, and semiconductors. Semiconductor behavior. Prerequisite: consent of the instructor.

16-506 ANTENNA THEORY AND DESIGN **(3-0)3**
Introduction to the fundamental principles of antenna theory, analysis, synthesis, and design. Antenna parameters. Electromagnetic fields due to prescribed sources, near and far regions, and reciprocity. Infinitesimal dipole. Arrays (patterns, mutual coupling). Array synthesis. Dipole linear wire, loop, traveling wave, frequency independent, aperture, and horn antennae. Prerequisite: 16-461.

16-507 ELECTROMAGNETICS I **(3-0)3**
Maxwell's equations and boundary conditions. Electric and magnetic potentials. Static approximations, boundary value problems, and solutions by separation of variable technique. Plane waves, dispersion, polarization, reflection, and refraction. Guided waves, transmission lines, and waveguides. Cavity resonators. Radiation by simple structures. Field and power calculations. Prerequisite: 16-461.

16-509 LINEAR SYSTEMS ANALYSIS **(3-0)3**
Review of linear signal and system theory. The Fourier and bilateral Laplace transforms. The Z-transform. Convergence properties. Discrete-modulation, sampling, and stability. Prerequisite: 16-362.

16-510 DIGITAL SIGNAL PROCESSING **(3-0)**
Definition of discrete signals and systems. Difference equations. Representation of linear, shift-invariant, discrete systems. Z-tranform. Discrete Fourier tranform and series. Digital filtering and digital filter design. Computation of the discrete Fourier transform. Discrete random signals.

16-513 MODERN CONTROL THEORY **(3-0)3**
The state-space, algebraic approach to linear time-invariant and time-varying systems. Controllability and observability. Time domain design of feedback control systems, continuous-time and discrete-time systems. Prerequisites: 16-362 or 16-509 and 92-523 or equivalent.

16-519 DIGITAL CONTROL SYSTEMS **(3-0)3**
A study of systems which include digital microcontroller element(s) for real time processing applications. Case studies include systems in the areas of process control, flight control, air traffic, and navigation systems. Environmental and pollution control systems.

16-520 APPLIED NUMERICAL METHODS **(3-0)3**
Taylor series. Number systems and error. Difference and summation calculus. Interpolation. Definite integrals. Differential equation modeling and stability. Predictor-Corrector and Runge-Dutta methods. Orthogonal polynomials. Discrete transforms. Roots of polynomials. Zeros and stationary points of single variable functions. Gradient, quasi-Newton, and conjugate gradient methods of optimization.

16-522 DATA STRUCTURES **(3-0)3**
Character strings and character substring searches; lists, their storage structures, and uses; trees, tree searches, and storage concepts; compiling, Polish strings, translating from infix to postfix and prefix, and conversion to machine code. Prerequisite: FORTRAN and Pascal or instructor's permission.

16-524 PROGRAMMING LANGUAGES **(3-0)3**
Syntax and semantias of programming languages. Fundamental concepts of control structures modularity, scope of identifiers, recursion, and data structures are covered. Examples of real programming languages such as FORTRAN-77, Pascal, LISP, APL, and ADA are included. Prerequisite: FORTRAN.

16-525 SIMULATION TECHNIQUES **(3-0)3**
A study of modern techniques for the simulation of continuous and discrete time systems and processes. Model building, simulation organization, statistical consideration, and model validation will be discussed. Study of a number of physical and engineering systems through the use of simulation techniques on available computers. Semiconductor models, discrete and integrated. Prerequisites: FORTRAN, 16-366.

16-531 ACTIVE NETWORK SYNTHESIS **(3-0)3**
Controlled sources. Impedance convertors and invertors. Synthesis techniques using the negative impedance convertor, the gyrator, and the operational amplifier. Active filter theory. Transcendental systems. Continued fraction expansions. Canonic realizations. Prerequisite: 16-366.

16-532 COMPUTATIONAL ELECTROMAGNETICS **(3-0)3**
Formulation of electromagnetic problems for computer solution. Variational principles in electromagnetics. Method of moments. Applications in electrostatics, wire antennas, waveguides, and cavities. Simple scattering problems. Finite difference methods. Finite element method. Prerequisite: 16-461.

16-533 MICROWAVE ENGINEERING **(3-0)3**
TEM and Quasi-TEM transmission lines. Strip, microstrip, slot, and coplanar lines. Rectangular and circular waveguides. Dielectric image line. Microwave circuit theory. Z,Y, scattering, and ABCD parameters. Passive components. Ferrites. Microwave measurement techniques. Prerequisite: 16-461.

16-534 MICROWAVE LABORATORY **(2-3)3**
Measurement of frequency and wavelength. Measurement of standing wave ratio and shift in minima. Measurement of dielectric constant for lossless and lossy dielectrics. Measurement of power. Measurement of return loss and S-parameters of a junction. Input impedance of an antenna over a ground plane. Prerequisite: 16-403 or 16-533.

16-537 INTRODUCTION TO BIO-MEDICAL ENGINEERING **(3-0)3**
A survey of the use of engineering methods in the life sciences. Topics covered include instrumentation techniques and devices, computer diagnosis of disease, computer-aided data analysis, telemetry, ultrasonic techniques, artificial organs, prosthetic devices, biological modeling, and simulation. Necessary biological background information is introduced as needed. Prerequisite: 16-366.

16-543 THEORY OF COMMUNICATIONS **(3-0)3**
Information transmission and deterministic signals in time and frequency domains. Relationship between correlation and power or energy spectra. Statistical properties of noise. Spectral analysis and design of AM, FM, and pulse modulation systems, continuous and discrete. AM, FM, and various pulse modulation methods in the presence of noise. Prerequisite: 16-362 or equivalent.

16-545 CODING THEORY **(3-0)3**
Concepts and recent developments in the use of codes for error control in data handling systems. Encoding and decoding procedures and their implementation in computational algorithms and hardware organizations are investigated in detail.

16-548 INFORMATION THEORY **(3-0)3**
Probabilistic measure of information. Determination of the information handling capacity of communication channels and fundamental coding theorems. Introduction to information coding and error correcting codes. Prerequisite: 92-386 or equivalent.

16-561 COMPUTER ORGANIZATION AND DESIGN **(3-0)3**
Structure of computers, past and present: first, second, third, and fourth generation. Combinatorial and sequential circuits. Programmable logic arrays. Processor design: information formats, instruction formats, arithmetic operations, and parallel processing. Hardwired and microprogrammed control units. Virtual, sequential, and cache memories. Input-output systems, communication, and bus control. Multiple CPU systems. Prerequisites: 16-217, 16-265.

16-562 MICROPROGRAMMING **(3-0)3**
Basic computer organization, including hardware resources, primitive basic computer operations, and generation of control information. Evolution of microprogramming technique and a simple microprogrammable machine (SMM). Overview of hardware components, control store design timings, ALU design, main memory, and data paths. Microinstruction design, including veritcal-horozontal and diagonal encoding characteristics for the SMM. Microinstruction implementation including serial, parallel, and mono-polyphase characteristics. Microprogramming languages and their emulators, simulators, and implementation. Computer description languages with examples from bit-slice microprocessor design. Prerequistes: 16-217,16-265.

16-563 SYSTEM PROGRAMMING **(3-0)3**
The definition of system programming as programming in a multi-user environment. Programming with and for interrupts. Reentrant programming, pure procedures. Communication between program modules. Nested calls, the push-down stack. Recursive program calls. Reentrant interrupt programming. Activation records and program sharing. Memory allocation by absolute and relocatable loaders. Macro languages, macroprocesses, and introduction to assemblers and macro assemblers. Prerequisite: 16-217.

16-564 OPERATING SYSTEMS **(3-0)3**
The resources of a large computer system. Sequential and concurrent processes in large digital computers. Design objectives: program sharing, multi-programming, multi-processing memory-sharing and protection. Process and communications and critical processes in operating systems. Scheduling, paging, segmenting, and swapping strategies. Time sharing and multiple-task operating systems. Design and simulation of operating system behavior. Operating system performance evaluation. Introduction to the UNIX operating system with C language programming. Prerequisite: 16-217.

16-571 RADAR SYSTEMS **(3-0)3**
Introduction to both pulsed and C. W. radar systems. Detection of radar echoes in noise. The radar equation and its use in estimating performance of a radar system. Estimation of range, direction, and velocity of targets. Moving target indicators. Pulse compression and other advanced techniques. Discussion of elements of practical radar systems. Prerequisite: 16-439 or 16-543.

16-574 INTRODUCTION TO DIGITAL SYSTEM DESIGN **(3-0)3**
A review of combinatorial and sequential circuit concepts at both the bit and register levels, number systems, binary adders, shift registers, and memories. The definition of a basic set of control operations and data modules are used to develop a register-transfer-level language to flowchart and document design algorithms. The algorithmic designs of special purpose MSI and LSI devices are studied and compared. Either hardware implementations

or computer-assisted simulations, using SIMRTM, are conducted to assist in an elevation of the cost, performance, and adaptability of each design algorithm. Applications include asynchronous processing, parallel processing, stacks, queues, microprocessing, special purpose processors, microcoded processor, and I/O interfacing techniques. Prerequisites: 16-217,16-265,16-366.

16-582 RADIO FREQUENCY COMMUNICATION SYSTEM DESIGN (3-0)3
Ground wave, sky wave, and tropospheric wave propagation of radio frequency signals. Line-of-sight communication and over-the-horizon radar systems. Design calculations for radio links between earth stations. Prerequisite: 16-461.

16-583 WAVE PROPOGATION IN PLASMAS (3-0)3
Interaction of electomagnetic radiation with plasma, specifically addressing the earth's ionosphere. Concepts of refraction, reflection, dispersion, absorption, and ray paths. Ionospheric effects on ground-to-ground and ground-to-satellite radio communication and over-the-horizon radar systems. Prerequisite: 16-461.

16-584 PROBABLILITY AND RANDOM PROCESSES (3-0)3
Axiomatic definition of probability. Combined experiments, Bernoulli trials, asymptotic theorems, Bayes theroems. Discrete and continuous random variables with functions of one or more random variables, and the continuous probability density function. Expected value, moments, characteristic functions, and mean square estimation. Introduction to random processes. Time averages and ensemble averages. Autocorrelation function and power spectral density.

16-602 ADVANCED VLSI DESIGN (3-0)3
Logic abstraction, digital circuit optimization techniques, clocks and communication design of array structures. The micro-architecture of VLSI systems. SPICE models for regenerative logic circuits and memories. Selected laboratory exercises. Prerequisite: 16-502.

16-603 SOLID-STATE PHYSICAL ELECTRONICS II (3-0)3
Semiconductor devices: Schottky diodes, p-n junction devices, junction transistors, FETs photo-diodes, and varactors. Electro-optic devices, thermo-electic devices, electro-luminescent diodes, and laser diodes. Prerequisite: 16-503.

16-604 MICROWAVE DEVICES (3-0)3
Review of EM Theory. P-n junctions. Varactors and SRD multipliers. Microwave transistors. Tunnel diodes. FETs. Transferred electron devices— Gunn diode. LSA avalanche diodes-IMPATT. TRAPATT and BARITT diodes. Quantum electronic solid state sources—ruby masers and semiconductor lasers. Parametric and IR devices. Prerequisite: 16-503.

16-605 SELECTED TOPICS IN SEMICONDUCTORS (3-0)3
Advanced material processing: state of the art fabrication technology for integrated circuits, amorphous and liquid semiconductors. Comprehensive study of Ga-Al-As Ga-In-As and super lattice structures. Prerequisite: 16-502 or 16-503.

16-607 ELECTROMAGNETICS II (3-0)3
Plane wave representation of electromagnetic waves. Angular spectrum of plane waves for two and three dimensions. Green's function method of solution for self adjoint boundary value problems. EM wave propagation in stratified media. Dyadic Green's function and applications. Prerequisite: 16-507.

16-608 SCATTERING AND DIFFRACTION OF EM WAVES (3-0)3
Review of EM theory. Scattering from a long cylinder for TM and TE waves. Scattering pattern and crosssection. Scattering from a sphere. Raleigh and Mie regions. Half plane

and wedge diffraction. GTD and applications for high frequency scattering. Babinet's principle and diffraction by an aperture. Physical theory of diffraction. Wiener-Hopf Methods. Prerequisite: 16-507 or equivalent.

16-609 INVERSE SCATTERING AND SOURCE THEORY (3-0)3
Inverse scattering theory. Characterization of scatterer from the scattered wave. Synthesis of transmission lines with specified transmission and reflection properties. Inverse source theory and synthesis of sources to give prescribed radiating waves and signals. Soliten theory. Prerequisite: 16-507 and permission of the instructor.

16-613 NONLINEAR CONTROL SYSTEMS (3-0)3
Analytic and numeric methods for the analysis and design of nonlinear control systems. Phase plane, describing function, the methods of Lyapunov and Popov, and other techniques are treated. Prerequisite: 16-513.

16-614 OPTIMAL CONTROL THEORY (3-0)3
Deterministic optimal control systems. Performance measures for optimal systems. Dynamic programming and related computer techniques. Discrete linear regulator. The Hamilton-Jacobi-Bellman equation. Continuous linear regulator. Calculus of variations and Pontryagin's minimum principle. Minimum time problems. Minimum effort problems. Prerequisites: 16-509 and 16-513.

16-620 ROBOTICS (2-2)3
Movement and imaging under the homogeneous representation. Robotic joints. Classification and analysis of robots. Inverse kinematic solutions. Parametric description of curves. Curved surfaces and triangular Bezier patches. Joint determination with curved surfaces. Introduction to artificial vision systems. Prerequisite: 16-509.

16-621 COMPUTER AIDED DESIGN (2-2)3
Closed and open form systems. Convergence strategies for open form systems. Nested programming methods and program structures. Data reduction and presentation. Applications to electrical networks and other physical systems. Prerequisite: 16-509.

16-637 BIOLOGICAL SYSTEMS (3-0)3
A discussion of the application of modern control theory to the study of biological systems. Modeling and simulation techniques are emphasized. Biological background information is introduced as required. Prerequisties: 16-413,16-445,16-537.

16-661 COMPUTER/LOCAL AREA NETWORKING (3-0)3
Characteristics and topology of Local Area Networks (LANs). Access control protocols. Standards. Design of cable-plants. Digital data switch. Voice/data computerized CBX. Device/LAN interfaces. Performance and evaluation of LANs and computer networking. Prerequisite: 16-561.

16-663 COMPILER STRUCTURES (3-0)3
Translators and interpreters for programming languages. Syntax of programming languages, syntax directed compilation. Parsing techniques: operator precedence, top down, bottom up, and reductive strategies. Intermediate forms and symbol tables. Generation and optimization of machine code. Error handling-detection and correction. The run time environment, storage allocation. Mathematics 92-569 may be substituted for this course. Prerequisite: 16-563, Pascal.

16-674 DIGITAL SUBSYSTEM DESIGN (2-2)3
A continuation of the design process developed in 16-574 with emphasis on developing algorithms at the register transfer level. Decomposition of these algorithms into detailed

RTL flowcharts showing register transfers. Control and timing sequences using a standard bussing scheme. A hardware term project of reasonable scope is required of each student along with a complete report detailing the design and use of the project system hardware and software. Prerequisite: 16-574.

16-675 ADVANCED DIGITAL DEVICES (3-0)3
State of the art microprocessors are examined and compared with their eight bit counterparts. The four architectional concepts of memory segmentation, operated addressing structure, operation register set, and instruction encoding scheme are evaluated between difficult families of processor design. Arithmetic and logical instruction support for high performance numeric processing requirements are discussed using numeric data processors. Prerequisite: 16-574.

16-676 DIGITAL SYSTEM DESIGN LABORATORY (2-3)3
The objective of this course is to explore applications of digital devices and systems to realistic engineering problems. Students are required to design and develop, build and test systems, emphasizing current state of the art digital developments. This is a limited enrollment course and requires extensive time in the laboratory. Prerequisite: 16-574.

16-685 STATISTICAL COMMUNICATION THEORY (3-0)3
A study of statistical communication problems. Particular topics include the description of signals and noise as stochastic processes. Signals, noise in demodulation. The continuous-time matched filter and Weiner filter. The multinomial Gaussian probablility density and Gaussian derived densities. Prerequisite: 16-684 or permission of instructor.

16-686 RANDOM PROCESSES (3-0)3
Definition of a random process. Bernoulli and Poisson processes, quadratic mean convergence, integration and differentiation of random processes. Application to topics such as statistical filtering and estimation, queueing theory, reliablity, communication theory, statistical physics. Prerequisite: 16-684.

16-687 STOCHASTIC ESTIMATION THEORY AND APPLICATIONS (3-0)3
A review of random vectors. Estimation theory for dynamic systems based on Bayesian and maximum likelihood methods. Discrete-time and continuous Kaimen filter with applications. Smoothing of discrete-time signals. Parameter identification and adaptive estimation. Prerequisite: 16-685 or 16-686.

16-700 SEMINAR (3-0)3
Presentation of oral proposals on an advanced engineering topic which are modified and redefined as required. Scholarly oral presentation of investigation outlined in proposal before the class and instructor. Grade based on clarity of exposition, knowledge of subject, ability to answer questions clearly and effectively, as well as participation in the discussions of other papers. Class size limited to ten students. Prerequisties: minimum of 15 credit hours of graduate courses: for students in the non-thesis option only.

16-710 through 16-729 SELECTED TOPICS IN ELECTRICAL ENGINEERING (3-0)3
Advanced topics in various areas of electrical engineering and related fields. Prerequisites: will be specified at time of offering.

16-730 ELECTRICAL ENGINEERING THESIS (9-0)6
The report on the research work performed under the supervision of a faculty member. Must be published in appropriate form and presented to a committee of three faculty members appointed at the time of acceptance of the thesis proposal. The student is required to give an oral defense of the thesis before the committee and other faculty members.

The committee may recommend to the Graduate Affairs Committee that more than 6 credit hours be granted for work of an exceptional nature. Prerequisites: minimum of 15 credit hours of graduate courses at an acceptable level and approval of a written proposal outining the extent and nature of proposed research work.

16-731 COMPUTER ENGINEERING THESIS **(0-9)6**
The same prerequisites and course requirements as in 16-730 apply.

16-732 SYSTEMS ENGINEERING THESIS **(0-9)6**
The same prerequisites and course requirements as in 16-730 apply.

DEPARTMENT OF INDUSTRIAL TECHNOLOGY

Donald S. Pottle, Department Head

Professor: H. Jack Apfelbaum

Associate Professors: David A. Colling, Nancy T. Miu, Donald S. Pottle, Robert J. Tuholski

Assistant Professors: John D. Colluccini, Paul A. Kales, James G. Keramas, Lawrence R. Maloney, Peter S. Vail

Instructor: V. Edward Simms, Jr.

The industrial technology program leads to the degree of Bachelor of Science in Technology. It prepares students for professional opportunities in production, manufacturing, and operational systems. The emphasis is on manufacturing and production management and computer integrated manufacturing (CIM). Graduates will be ready for careers in manufacturing operations, establishing and supervising production procedures, and undertaking managerial responsibilities in the private and public sectors.

The program couples interdisciplinary work with practical experience in technically oriented subjects. The curriculum encompasses a wide range of engineering as well as business and management subjects. Substantial emphasis is placed on laboratory work involving application of classroom learning to practical situations.

One feature of the program is the popular Cooperative Education (CoOp) option. Fully 30 percent of those students who are eligible take advantage of this option which incorporates supervised industrial experience into their educational program with academic credit.

Curricular requirements virtually ensure a well-balanced education. Approximately 40 percent of the curriculum focuses on technical and engineering subjects; 20 percent on business and management; another 20 percent on the social sciences and humanities; and the balance in mathematics and sciences. Electives permit rounding of technical interests or the pursuit of unrelated subjects.

The department maintains a flexible transfer policy. A student without transfer credit or advanced standing will take an average of 16 credits per semester.

A student chapter of the Society of Manufacturing Engineers (SME) provides professional and social opportunities for all students. The department also sponsors a student chapter of the American Society for Quality Control.

COURSE OF STUDY FOR INDUSTRIAL TECHNOLOGY
(Bachelor of Science in Technology)

Freshman Year

Fall Semester			Spring Semester		
20-105	Intro. Eng. Design (L)	3	20-112	Mach. Tool Proc. (L,P)	3
42-101	College Writing	3	42-102	College Writing & Lit.	3
64-201	Economics I (Area I)	3	47-101	Gen. Psychology (Area I)	3
84-111	Gen. Chemistry	3	92-122	Diff. Calculus (P)	3
84-113	Gen. Chem. Lab	1	95-151	Elem. of Physics	3
92-121	Pre-Calculus Math.	3	96-151	El. Exp. Physics	1
39-	Phys. Ed. Activity	0.5	39-	Phys. Ed. Activity	0.5
39-	Phys. Ed. Activity	0.5	39-	Phys Ed. Activity	0.5
		17			17

Sophomore Year

Fall Semester			Spring Semester		
20-202	Ind. Computer Science	3	20-201	Intro. to Materials (L,P)	4
20-290	Ind. Electricity (P)	3	42-225	Tech. & Sci. Writing	3
20-291	Ind. Elec. Lab (P)	1	26-211	Plastics Mat'l Science	3
20.205	Mechanics for Technology (P)	3	92-383	Intro. to Statistics	3
92-201	Integral Calculus	3		Area II Elective	3
	Area II Elective	3			
		16			16

Junior Year

Fall Semester			Spring Semester		
20-306	Fluid Power Ctrl. (P)	2	20-308	Indus. Electronics (P)	3
20-307	Fl. Power Control Lab	1	20.309	Ind. Elec. Lab	1
20-305	Manufacturing Processes (L,P)	3	20-303	Mechanical Systems (P)	3
20-310	Industrial Safety (P)	3	20-314	Motion & Time Study (P)	3
66-371	Operation Mgt. I (P)	3	66-353	Org. Behavior (P)	3
60-201	Accounting I	3		Area I or II Elective	3
	Gen. Elec. or Co-op	3			
		18			16

Senior Year

Fall Semester			Spring Semester		
20-402	Manuf. Operations (L,P)	3	20-306	Energy Engineering (P)	3
20-414	Engineering Economics (P)	3	20-416	Stat. Qual. Control (P)	3
20-407	Inst. & Proc. Ctrl. (P)	4	62-301	Marketing Princ. (P)	3
20-408	I.P.C. Lab	1		Tech. Elect., ROTC,or Co-op	3
	Tech. Elect., ROTC, or Co-op	3		Tech. Elect.	3
	Human Values req.	3			
		16			15

L = LAB P = PREREQUISITE

Industrial Technology (Course Prefix: 20)

20-105 INTRODUCTION TO MECHANICAL DESIGN I,II(2-2)3
Introduction to industrial practice in design graphics, sketching, orthographic projection, sectioning, dimensioning, tolerances, and fasteners. The reading of blueprints is practiced throughout this course.

20-112 MACHINE TOOL PROCESSES I,II(2-2)3
An introduction to fundamental machine shop techniques, covering machining practices, measurement and layout, and general shop safety. The objective is to develop an appreciation for basic machine tool practices utilized in manufacturing, and in industrial

maintenance and repair activities. Prerequisite: 20-105

20-201 INTRODUCTION TO MATERIALS **I,II(2-3)4**
A practical study of the relationship among properties, composition, and structure of metals. This course includes selection, crystal structure, alloy phase diagrams, solidification, and heat treating principles of metals, as well as their application in normal and extreme environmental conditions. The course also emphasizes joining methods and deformation processing of metals. In addition, ceramics, concrete, composite materials, and powder metal processing are considered. Laboratory studies include soldering, adhesives, and welding, in addition to testing procedures. Prerequisites: 84-111,84-113.

20-202 INDUSTRIAL COMPUTER SCIENCE **I,II(3-0)3**
An introduction to the use of computers in industry through the use of structured FORTRAN 77 and COBOL, high order languages for scientific and business applications, respectively. Nine working programs are required which emphasize the use of major structures from the languages.

20-205 MECHANICS FOR TECHNOLOGY **I,II(3-0)3**
An introduction to mechanics of solids. The course introduces free-body mode of equilibrium analysis, statics, and strength of materials. It examines problems on static friction, framed structures, centroids, welded and pivoted joints, and thin-walled pressure vessels. Basic stress-strain relations and their application to practical problems. Prerequisites: 92-121,92-151.

20-290 INDUSTRIAL ELECTRICITY **I,II(3-0)3**
Topics include Ohm's Law, Kirchhoff's Law, Thevenin's Theorem, and Superposition Theorem. Power consumption, power factors, three phase circuits, transformers, DC/AC generators, and motors are also included. Prerequisites: 92-122,95-151.

20-291 INDUSTRIAL ELECTRICITY LABORATORY **I,II(0-2)1**
The goals of this course are to give the student a hands-on experience with the subjects covered in the course.

20-303 MECHANICAL SYSTEMS **I,II(3-0)3**
An introduction to the principles of mechanical power transmission. Students learn design of mechanical elements such as shafts, pulleys, gears, gear trains, cams, bearings, clutches, brakes, and springs. Students will gain experience working with commercially prepared tables. Prerequisite: 20-205.

20-305 MANUFACTURING PROCESSES **I,II(2-2)3**
This course is a continuation of Machine Tool Processes. Course work covers an introduction to nonconventional machining, electrical discharge machining, lasers, and various forms of chemical and electromechanical machining, automatic manufacturing concepts ranging from electromechanical operations to fundamentals of numerical control manufacturing and robotics. The objective is to develop broad understanding of manufacturing operations and product design/manufacturing relationships. Laboratory experience includes nonconventional machining, and numerical control operations and programming. Prerequisite: 20-112.

20-306 FLUID POWER CONTROLS **I,II(2-0)2**
The elements of hydraulic and pneumatic power systems and their control. Elements such as cylinders and valves are studied in detail and combined to form complete circuits coupled with relay and pneumatic control. Prerequisite: 20-205. Corequisite: 20-307 laboratory.

20-307 FLUID POWER CONTROL LABORATORY **I,II(0-2)1**
Laboratory exercises involving hydraulic and pneumatic circuits, cylinders, valves, pumps, relays, and Boolean logic. Corequisite: 20-307 lecture.

20-308 INDUSTRIAL ELECTRONICS **I,II(3-0)3**
This course consists of both digital and analog circuits. Topics include number systems, Boolean algebra, logic gates, implementation of logic functions, DeMorgan's Theorem, adders, Encoder/Decoder multiplexers, and counters. Other topics include semiconductor devices, diodes, transistors, rectifiers, amplifiers, and operational amplifiers. Prerequisite: 16-290 or 20-290 Corequisite: 20-309 laboratory.

20-309 INDUSTRIAL ELECTRONICS LABORATORY **I,II(0-2)1**
Extensive work with diagrams and the use of instruments, meters, signal generators, and oscilloscopes. Corequisite: 20-308 lecture.

20-310 INDUSTRIAL SAFETY **I,II(3-0)3**
A practical study of industrial safety and accident prevention. Studies include hazard analysis, safety management, engineering remedies, and risk management. Numerous practical cases are presented and the role of governmental agencies in safety is analyzed. Prerequisite: junior standing.

20-314 MOTION AND TIME STUDY **I,II(3-0)3**
Productivity methods improvement, facilities planning, and work measurement techniques, including principles of motion economy, work simplification, process and operator charts, work sampling, performance rating, and time standards. This course emphasizes verbal and written communication skills. Prerequisites: 92-121,20-112 and junior standing.

20-354 INDUSTRIAL WASTE TREATMENT **II(3-0)3**
An introductory course to the operation of control of the major types of industrial waste treatment processes, including those associated with food processing, paper, and metal finishing. The course will include basic lab work with pH and solids.

20-402 MANUFACTURING OPERATIONS **I,II(2-2)3**
This course combines work on an actual industrial project with class work related to plant layout, project control, and materials management. Several case studies are used to examine these activities. As part of the project, students must contact companies, find a project, undertake the project, and report on all stages of the project. Prerequisite: senior standing.

20-406 ENERGY CONVERSION **I,II(3-0)3**
An introduction to the laws and concepts of thermodynamics: the first and second laws, properties of liquids and gases, and common power cycles. An overview of the energy problem and power generation technologies, both established and novel, is included. Prerequisites: 84-111,95-151,20-205.

20-407 INSTRUMENTATION AND PROCESS CONTROL **I,II(3-0)3**
The microprocessor (Motorola 6802) and its programming concepts regarding control loops and counters. This course also covers one, two, and three mode controllers, as well as measuring means and their characteristics. Prerequisite: 20-290 Corequisite: 20-409 laboratory.

20-409 I. P. C. LABORATORY **I,II(3-0)3**
Practical experience in the design of microprocessor programs and data collection on tow and three mode controllers.

20-410 INDUSTRIAL MICROPROCESSOR APPLICATIONS **II,(2-2)3**
Interface industrial applications of the Motorola 6800 family of 8-bit microprocessors are emphasized in this course. Necessary interface devices will be integrated with this microcom

puter and a fully integrated 8-bit controller, and the Motorola MC 68 HC11 will be considered. Each student will be required to conduct independent, semester-long, research projects. Prerequisite: 20-407.

20-414 ENGINEERING ECONOMICS **I,II(3-0)3**
The analysis of economic effects of engineering decisions with emphasis on the allocation of limited financial resources among competing investment alternatives. Economic evaluation of plans, programs, and projects using methods of present worth, annual cash flow, (internal) rate of return, benefit-cost ratio, and incremental analysis. Depreciation methods and their effects on after-tax cash flows. Replacement analysis for retirement of assets and alternatives for the future. Prerequisites: 92-121,60-201.

20-416 STATISTICAL QUALITY CONTROL **I,II(3-0)3**
A study of the statistical and administrative techniques related to the assurance of product and service quality and producer/consumer interaction. The application of sampling techniques and control charts to the manufacturing environment will be examined. Correlation and regression analysis will be utilized. Prerequisites: 92-383 or equivalent, 20-305.

20-423 PRODUCT LIABILITY **(3-0)3**
Product liability is of increasing importance to industrial engineers due to legal decisions which assign liability for safe products to original manufacturers and individual engineers. In this course the legal aspects of negligence and strict and implied liability are studied and the role of engineers in the design, manufacture, and testing of safe products is defined. The role of government agencies such as the Consumer Product Safety Commission will be examined. Numerous product liability cases will be reviewed, analyzing the legal bases for establishing liability for product failure. Prerequisite: senior standing.

20-425 VALUE ENGINEERING **(2-2)3**
Value engineering is a design discipline aimed at achieving the necessary products or services at minimum cost. Using case studies, laboratory design work, and lectures, the principal methods of value engineering are presented and applied to practical problems. Prerequisite: senior standing.

20-436 ROBOTICS **(3-0)3**
This course covers the history of robots, their industrial applications, robot technology, and robot accessory technology. Also covered are sensing devices, work, cell design, robot interfacing, safety problems, and the future implications of robots. Individual and group projects in robotics are an essential part of the course. Prerequisite: senior standing.

20-491 (20-492) SPECIAL PROJECTS **I,II(1-4)3**
Directed industrial experience in planning, executing, and reporting of an individual project selected by the student in consultation with a faculty member of the Industrial Technology Department. Prerequisite: senior standing.

Primarily for graduate students but may be taken as electives by undergraduate Industrial Technology majors with the permission of the instructor and the academic advisor.

20-510 HUMAN FACTORS IN ENGINEERING **(3-0)3**
Surveys the discipline of human factors and illustrates its importance in designing tools, equipment, and other systems for more efficient, safe, and tolerable human use. Equips students to consider human strengths and limitations in such physical aspects as movements and reach, and in such mental aspects as attention, perception, memory, and cognition in the design of manufacturing systems.

20-515 INDUSTRIAL AUTOMATION (3-0)3
Manufactring productivity and industrial automation, emphasizing the latest developments and techniques to produce the least expensive process consistent with acceptable quality control. Topics will include: product design, human resources, equipment justification, project management, basic systems concepts, parts feeding, positioning devices, fastening methods, inspection functions, ancillary operations, controls, debugging, people, and automation.

COMPUTER INTEGRATED MANUFACTURING I (3-0)3
The current status and future role of computers, robots, automation, and automatic data handling in manufacturing and related functions will be examined. Human and sociological factors related to the planning and implementation of computer integrated manufacturing will be reviewed.

20-526 COMPUTER INTEGRATED MANUFACTURING II (3-0)3
A continuation of the material of 20-525, Computer Integrated Manufacturing I.

20-530 ELECTRONIC MATERIALS AND PROCESSES (3-0)3
Electronic, magnetic, and semiconductor properties of materials used in the electronics industry. Manufacture of silicon chips, bonding and electronic packaging of integrated circuits, manufacture of printed wiring, and assembly of printed circuit boards will be examined.

20-535 MICROPROCESSOR APPLICATIONS (3-0)3
Microprocessor architecture, instruction set, addressing modes, program, and memory requirements. Peripheral devices and interfacing techniques, with emphasis on control system applications.

20-540 SYSTEM CONCEPTS IN SAFETY (3-0)3
The application of systems concepts are extended to the industrial safety field. Management modules, concepts, quality circles, human error concepts, and ergonomic considerations will be discussed in detail, using numerous case studies involving fire hazards, machinery safeguarding, material handling, and slips and fall hazards.

20-545 ECONOMIC FORECASTING FOR THE INDUSTRIAL MANAGER (3-0)3
Macroeconomic analysis and microeconomic analysis and how they can be used to control exogenous factors.

20-550 RELIABILITY ENGINEERING (3-0)3
Introduction to reliability and maintainability design techniques, methods of predicting failure rates, data assessment methods, determination of mean-times-to-failure, availability concepts, failure-modes-and-effect-analysis, fault-tree-analysis, spares provisioning, and reliability modeling for non-maintained systems.

DEPARTMENT OF MECHANICAL AND ENERGY ENGINEERING

Richard Madden, Department Head

Professors: Frederick Bischoff, Gilbert Brown, Maximilian Etschmaier, Richard Gaggioli, William Hogan, Richard Madden, Jose Martin, Alan Mironer, Eugene Niemi, John O'Callahan, James Phelps, Kenneth Rogers, James Sheff, G. Dudley Shepard

Associate Professors: Craig Douglas, John Duffy, Michael Ellenbecker, James Flanagan, Zelman Kamien, James A. Moore, Struan Robertson, Woon-Shing Yeung, Yakov Zilberberg

Assistant Professors: Chaur-Ming Chou, Majid Charmchi, John McKelliget, Arthur Petrou, John R. White

Instructors: Kendrick Lentz, Joseph Ustinowich

The Mechanical and Energy Engineering Department offers two distinct undergraduate programs in Mechanical Engineering and Nuclear Engineering. Both share a common objective of providing a broad, fundamental base from which graduates can develop their skills by entering general engineering practice or pursuing an advanced engineering degree.

The first component of both programs consists of courses in humanities, social sciences, and basic sciences to broaden perspectives, provide a firm understanding of fundamentals, develop analytical techniques, and prepare for specialized engineering courses.

A second component consists of courses that provide an introduction to engineering, link the basic sciences and engineering, and introduce the methodology of engineering analysis, synthesis, and design.

A final component of the curriculum consists of the study of advanced problems and topics in engineering design. The purpose is to develop skill in the use of science and creativity in the solving of engineering problems.

A variety of laboratory work is included in each program to demonstrate the use of the experimental method in the solution of engineering problems. To permit necessary specialization, staff advisors aid in selecting technical electives consistent with future career plans.

Five Year Bachelor of Science/Master of Science in Engineering Program

For those wishing to pursue the five-year BS/MS in Engineering program, the first three years of course work is the same as that specified for students in the four year bachelor's program. In the senior year, however, students take one graduate course per semester. Students who elect this program receive the Bachelor of Science in Engineering degree at the end of the fourth year, the Master of Science in Engineering at the end of the fifth year.

COURSE OF STUDY FOR MECHANICAL ENGINEERING (Bachelor of Science in Engineering)

Freshman Year

Fall Semester		Spring Semester	
84-121/123 Chemistry	4	84-122/124 Chemistry	4
42-101 College Writing I	3	42-102 College Writing II	3
92-131 or 133 Calculus	4	92-132 or 134 Calculus	4
95-141/96-141 Physics	4	95-144/96-144 Physics	4
25-101 Intro. to Eng. Des.	2	25-127 Fortran	2
	17		17

Sophomore Year

Fall Semester		Spring Semester	
22-211 Mechanics I	3	92-234 Diff. Equations	3
25-295 Materials Engineering	3	22-212 Mechanics of Materials I	3
92-231 or 233 Calculus	4	22-213 Dynamics	3
95-245/96-245 Physics	4	22-242 Thermodynamics	3
H/S Elective*	3	H/S Elective	3
	17		15

Junior Year

Fall Semester		Spring Semester	
22-311 Applied Strength	3	22-354 Dynamic Systems	3
22-321 Princ. of Eng. Design	3	22-344 Heat Transfer	3
22-381 Fluid Mechanics	3	22-322 Machine Design	3
92-301 Applied Math I	3	22-302 ME Lab I	2
64-200 Economics	3	16-211 Electrical Engineering	3
		H/S Elective*	3
	15		17

Senior Year

Fall Semester		Spring Semester	
22-453 Auto Controls	3	22-423 Des. of Thermofluid Sys.	6
22-441 Analysis of Th/Fl Process	3	or	
22-421 CAD/CAM	3	22-471 Des. of Dyn. Sys.	6
22-451 Machine Dymanics	3	Technical Elective	3
22-403 ME Lab II	2	H/S Elective*	3
H/S Elective*	3		
	17		15

Total Credits = 130

* University and College of Engineering requirements must be met for humanities/social science (H/S) electives.

Mechanical Engineering (Course Prefix: 22)

22-211 MECHANICS I **I(3-0)3**
The application of Newton's Laws to engineering problems in statics. The free-body diagram method is heavily emphasized. Topics include vector algebra, force, moment of force, couples, static equilibrium of rigid bodies, truss analysis, friction, properties of areas, shear, and moment diagrams. Prerequisites: 92-132 or 92-134,95-144.

22-212 MECHANICS OF MATERIALS **II(3-0)3**
Stress and deformation analysis of bodies under axial, torsional, flexural and combined loading; failure loads, and buckling. Prerequisites: 92-231 or 92-233,22-211,25-127.

22-214 ENGINEERING MECHANICS **II(4-0)4**
The engineering aspects of mechanics. Topics include vectors, static equilibrium, rigid and deformable solids, stress and strain under various loading conditions, and mechanical properties of materials. Applications of Newton's second law, including momentum and energy, particle and rigid body motion, vibrations and electric analog, central force motion, collision. Prerequisite: 95-145. Corequisite: 92-234.

22-215 STATICS AND STRENGTH OF MATERIALS **I(4-0)4**
The application of Newton's Laws to engineering problems in statics. Topics include vector algebra, force, moment of force, couples, static equilibrium of rigid bodies, truss analysis, friction, properties of areas, stress and deformation analysis of bodies under axial, torsional, flexural and combined loading; failure loads, buckling. Prerequisites: 25-127,92-132,95-144.

22-216 DYNAMICS **II(3-0)3**
Vector development of kinematics of a particle with respect to fixed and moving coordinate systems of one, two, and three dimensions. The dynamics of a particle, system of particles, and rigid bodies. Angular momentum and the inertial properties of rigid bodies. Energy, impulse, and momentum. Prerequisites: 92-231,22-215.

22-218 APPLIED STRENGTH OF MATERIALS **II(3-0)3**
Three dimensional stress transformation and indical notation. The stress invariants and their application to energy methods, failure theories, and principal stresses. Advanced topics in strength of materials. Fatigue. Finite element analysis. Prerequisites: 22-215,92-233,25-127.

22-242 THERMODYNAMICS **II(3-0)3**
A detailed study of the first and second law as applied to an open and closed system in steady and unsteady flow. Thermodynamic properties of pure substances, condensible vapors, and the perfect gas. The concept of entropy, reversibility and irreversibility, vapor, and air standard cycles. Use of computer program to investigate performance of steam power cycle. Prerequisites: 92-231,92-233.

22-295 MATERIALS ENGINEERING **I,II(3-0)3**
The behavior of engineering materials is studied in a systematic manner to develop an understanding of why materials behave as they do. The main emphasis is on the relationship of the mechanical behavior and the internal material structure. Mechanical properties, processing methods, selection, and application of metals, ceramics, polymers, and composites as structural materials are examined.

22-302 MECHANICAL ENGINEERING LABORATORY I **II(0-3)2**
Experiments to illustrate and reinforce classroom concepts presented in Strength of Materials, Dynamics, and Materials Science. Students also acquire familiarity with some standard physical tests and testing equipment. Clear report writing is emphasized. Prerequisites: 22-212,22-215,25-295.

22-321 PRINCIPLES OF ENGINEERING DESIGN **I(3-0)3**
A basic engineering design course emphasizing design theory, graphics, and practice in preparation for advanced design courses. Lectures support laboratory design projects, emphasizing materials and process selection, design economics, and project planning implementation. Laboratories include six "mini" design projects that emphasize graphic development and presentation and an introduction to machine tools and to the University of Lowell CAD System. Prerequisites: 22-215,25-101,25-295.

22-322 MACHINE DESIGN **II(3-0)3**
The principles of mechanics and commonly used theories of failure applied to the design and analysis of typical machine elements that are subjected to various loading conditions. Laboratory work requires the solution of comprehensive machine design problems that illustrate the close relationship between analysis and synthesis in design. Prerequisite: 22-216,22-218,22-321.

22-344 HEAT TRANSFER **II(3-0)3**
Theory and application of steady and transient heat conduction in solids. Mathematical development of thermal boundary layer theory. Forced convection, natural convection. Development of thermal radiation with application to heat exchange between non-black bodies. Heat exchangers, log-mean temperature difference, effectiveness. FORTRAN computer project. Prerequisites: 22-381,92-301.

22-347 ELEMENTS OF THERMODYNAMICS AND HEAT TRANSFER I,II(3-0)3
Development of the concept of energy and the thermodynamic properties of matter. Energy and mass transfer between a system and its surroundings. Conservation laws for energy and matter. Second law of thermodynamics and the property of entropy. Heat transfer: steady state conduction, convection and radiation. Application to energy transfer and conversion devices.

22-354 ANALYSIS OF DYNAMIC SYSTEMS I(3-0)3
Development of the equations of motion for single and multi-degree of freedom problems in mechanical, hydraulic, pneumatic, and electrical systems. Emphasis is placed on the mathematical analogies among the various systems. Steady state, transient, and frequency response analyses are performed applying Euler's method and variation of parameters, Laplace transforms and numerical techniques using ACSL. Prerequisites: 16-211,92-234,22-216,22-381.

22-381 FLUID MECHANICS I(3-0)3
Development of basic fluid mechanical relations, continuity, momentum and Bernoulli equations. Emphasis on control volume approach to problem solving. Hydrostatics, internal flows, Reynolds number. External flows, mathematical development of hydrodynamic boundary layer, separation, fluid dynamic drag. FORTRAN computer project. Prerequisites: 22-215 or 22-214,22-242,92-234. Corequisite: 92-301.

22-403 MECHANICAL ENGINEERING LABORATORY II I(0-3)2
Experiments performed on equipment in the mechanical engineering laboratory and covering generally the areas of thermodynamics, fluid mechanics, heat transfer and controls. Participants are encouraged to analyze experiments by application of previously learned principles. Emphasis is placed on data acquisition and analysis and proper presentation in an engineering report. Prerequisites: 22-242,22-344,22-381. Corequisites: 22-441,22-453.

22-407 SENIOR PROJECT I I(0-3)1
Direct engineering experience in planning, executing, and reporting an individual project selected by each student in consultation with the M. E. staff. The first term is devoted to problem definition, solution synthesis and design analysis. Prerequisite: senior status and permission of the instructor.

22-408 SENIOR PROJECT II II(0-6)2
A continuation of 22-407. The second term is devoted to trade off and optimization, construction, testing, evaluation and reporting. Prerequisite: 22-407.

22-421 COMPUTER AIDED DESIGN I,II(2-3)3
The integration of computers into the total design process from concept through manufacturing. The course focuses on a full term design project requiring the use of computers in the areas of computer graphics, engineering analysis (Finite Element Analysis), computer aided manufacturing (3 axis CNC milling), and data acquisition. Lectures support project requirements, and provide more in-depth perspective on the concepts of computer-integrated design, engineering and manufacturing. Prerequisites: 22-322,22-354.

22-423 DESIGN OF THERMOFLUID SYSTEMS II(3-0)3
Basic design procedures in the field of thermal-fluid systems. Emphasis is placed on independent team efforts to develop the concept and some essential elements of system thermal design. The lecture part of the course addresses specifics of various thermal fluid systems design (steam power plants, refrigeration systems, residential, commercial, and industrial heating systems, air conditioning systems, water supply systems, cryogenic systems, etc.). Prerequisites: 22-321,22-344. Corequisite: 22-441.

22-424 CASE STUDIES IN DESIGN **I,II(3-0)3**
Case study analysis of design problems and processes encountered in industry. Cases encompass a wide range of engineering and business considerations including creative design and conceptualization, design methods, product design, materials selection, human factors, value engineering, design optimization, design for production, design for consumer appeal, design program planning, inventions and patents, product costing and pricing. Comprehensive overall design approach to real problems is emphasized, followed by inspection, discussion and critique of the product as it was actually designed. Prerequisite: 22-321,64-200.

22-425 DESIGN OF EXPERIMENTAL SYSTEMS **I,II(3-0)3**
Theory and practice of designing experiments and the systems required to implement the entire experimental program. Areas include experimental planning, statistical methods for design and analysis, instrumentation system design, instrument selection, data acquisition systems, microprocessor control and analysis, design of test hardware and fixturing. Use of case studies, laboratory demonstrations and a term project. Prerequisite: senior status.

22-426 DESIGN INNOVATION **I,II(2-2)3**
A project oriented course which stresses the design, analysis, fabrication, and testing of student devices. Each design project is used to reinforce lecture material or core curriculum basics. Lecture topics include the phases of design, idea generation, PERT, decision analysis, human factors, patent law, and design economics. Prerequisite: 22-321.

22-427 DESIGN OF AUTOMATIC MACHINERY **I,II(3-0)3**
Basic system approach to the design of automatic machinery emphasizing selection and integration of standard components and controls. Fundamentals of pneumatic, relay and microprocessor controls applied to pneumatic, electro-mechanical and mechanical sensing and actuating components. Basics of parts-handling positioning, assembly, automatic inspections and tests in a small machinery system. Prerequisite: 22-322,16-211.

22-428 HUMAN FACTORS IN ENGINEERING DESIGN **I,II(3-0)3**
The design constraints imposed on man-made objects and environments by human mental and physical limitations. Student ideas for designs will be developed in the form of detailed engineering proposals which reflect optimum solutions to man-machine interface problems. Prerequisite: senior status.

22-429 INDUSTRIAL HYGIENE ENGINEERING **I,II(3-0)3**
The course considers the major types of industrial exposures, including airborne containments, noise, heat stress, and ionizing and non-ionizing radiation. The primary emphasis is on the engineering methods for controlling exposures, including ventilation, process and equipment modifications, and personal protection equipment.

22-434 INTRODUCTION TO PROJECT ENGINEERING **I,II(3-0)3**
Introduction to contemporary methods for task and project management with orientation to the R&D environment. The lecture and case study method will be used, supplemented by oral and written presentations by each student. Emphasis will be placed on planning, programming and budgeting of all resources for process optimization.

22-441 ANALYSIS OF THERMO-FLUID PROCESSES **I(3-0)3**
Dimensional analysis, similitude, and modeling. Mixtures of ideal gases, air-water vapor mixtures with application to air conditioning. First law analysis of combustion. Flow of a compressible fluid through a nozzle. Mach number, choking, normal shock. Introduction to second law analysis, energy, irreversibility. Prerequisite: 22-381.

22-442 FUNDAMENTALS OF REFRIGERATION ENGINEERING I,II(3-0)3
Thermodynamic cycles of refrigeration machines and heat pumps. Types of refrigeration compressors, evaporators, condensers, and other heat transfer equipment. Thermodynamic and thermophysical properties of refrigerants. Thermodynamic behavior of mixtures (oil-freon). Adsorption and vapor-jet refrigeration machines. Special problems of heat pump design. Principles of automatic control for refrigeration machines and heat pumps. Prerequisite: 22-344. Corequisite: 22-441.

22-443 FUNDAMENTALS OF CRYOGENIC ENGINEERING I,II(3-0)3
Thermodynamic principles and analysis of cryogenic cycles. Air liquefaction and gas-mixtures separation cycles. Adsorption and rectification (distillation) processes and their analysis. Rectification columns, expanders, pumps, heat exchangers, compressors, storage vessels, insulation. Specifics of cryogenic equipment and instrumentation design. Superconductivity. Separation of inert gases (helium, argon, etc.). Safety considerations. Prerequisite: 22-344. Corequisite: 22-441.

22-448 ENVIRONMENTAL CONDITIONING I,II(3-0)3
The control of thermal environment within enclosed spaces including transfer of heat and work energy. Refrigeration cycles, heating humidification, dehumidification and mixtures. Design of conditioned spaces. Prerequisite: 22-242 or 22-347.

22-451 MACHINE DYNAMICS I(3-0)3
Concepts from statics, strength of materials, dynamics, and dynamic systems applied to the analysis of motions and forces leading to stresses in machine components. Covers synthesis of mechanisms including linkages, cams, and drive trains. Introduction to vibration analysis of single and multi-dof systems is used to study balancing of rotating components, critical whirling speeds of shafts, flywheels, and balancing of reciprocating masses. Topics such as fatique of machine components are also covered. Prerequisite: 22-322,22-354.

22-453 AUTOMATIC CONTROL SYSTEMS I(3-0)3
Concept of open loop and feedback control systems. Use of block diagrams and transfer functions for system representation. Transient and steady-state response using frequency response and root locus techniques. Stability and compensation. Consideration of hydraulic pneumatic, electromechanical, and thermal control systems. Prerequisite: 22-354.

22-456 EXPERIMENTAL STRESS ANALYSIS I,II(3-0)3
The determination of stresses and strains in loaded members by experimental techniques including photoelasticity, birefringent coatings, holography, Moire methods, brittle coatings, analogies, and strain gages. Prerequisite: 22-218.

22-461 INTRODUCTION TO FINITE ELEMENT ANALYSIS I,II(3-0)3
Finite element equations are developed in detail for one-dimensional problems in solids, fluids and heat conduction. Problems are solved by hand and with a special 1-D code. Certain 2-D problems are considered for which a general purpose code such as ANSYS will be used. Prerequisites: 22-218,22-344.

22-463 FUNDAMENTALS OF ENGINEERING MEASUREMENTS, INSTRUMENTATION, AND QUALITY CONTROL I,II(3-0)3
Basic review of probability and mathematical statistics. Evaluation of measurement errors. Concept of units and dimensions. Technical characteristics of measuring instruments. Static and dynamic properties of control instruments. Basic principles of and requirements for selection of instruments and devices for measurement and control purposes. Evaluation of proper settings and allowable tolerances. Sampling, reliability, and some basics of industrial quality control. Prerequisite: 92-301.

22-471 DESIGN OF DYNAMIC SYSTEMS II(3-0)3
Design of dynamic systems in a context similar to that met in industrial practice. Problem definition, performance specification, generation of multiple design alternatives, decision analysis of essential design trade-offs, and design optimization. Decision making on the basis of incomplete and ambiguous information. Prerequisite: 22-453.

22-472 VIBRATIONS I,II(3-0)3
Modeling and solution of multi-degree of freedom problems. Matrix methods are used along with an applications program. Shock spectrum methods and non-linear effects are considered. Prerequisites: 22-354,92-301.

22-481 FLUID MECHANICS II I,II(3-0)3
Introduction to the use of the digital computer for solving fluid mechanics problems. Laminar, viscous flows, hydrodynamic lubrication, Navier-Stokes equations. Introduction to turbulence, Reynolds stresses, eddy viscosity, Prandtl's mixing-length theory. Open-channel flow, hydraulic jump, uniform and non-uniform flow. Prerequisite: 22-381.

22-483 AERODYNAMICS I,II(3-0)3
Fundamentals of subsonic aerodynamics. Atmosphere models. Air speed measurement, boundary layers, aerodynamic heating. Circulation, downwash, and three-dimensional wing theory. Airfoil data, and lift and drag of aircraft components. Power required and power available. Introduction to aircraft performance calculations. Prerequisite: 22-381.

22-484 JET PROPULSION AND TURBOMACHINERY I,II(3-0)3
Air breathing jet propulsion, thrust, and propulsion efficiency. Thermodynamics of Brayton cycle, component efficiencies, and thermal efficiency. Comparison of propjets, turbojets, and turbofans. Detailed performance calculation of turbofan engine using measured data and high temperature gas properties. Turbomachinery, velocity triangles, Euler's turbomachinery equation. Axial flow compressor, rotating stall and surge stability compressor map. Axial flow turbines, exhaust nozzles, after burners. Engine component matching. Future trends in jet propulsion. Prerequisite: 22-441.

22-485 MECHANICAL ENGINEERING PROBLEMS IN OCEANOGRAPHY I,II(3-0)3
Fluid mechanics of ocean waves. Tidal waves, surface waves, wind driven waves, sea state classification of waves. Review of hydrostatics. Added mass. Stability and motion of ocean platforms and buoys. Forces on submerged mooring cables, and cable configurations. Dynamics of liquid spills on water. Prerequisites: 22-216, 22-381.

22-487 GAS DYNAMICS I,II(3-0)3
Extension of basic thermodynamic and fluid mechanical equations of motion to inviscid, compressible flows. One-dimensional, steady flows with area change. Fanno and Rayleigh flows. Normal and oblique shocks. Prandtl-Meyer expansion. Prerequisite: 22-441.

22-493 NON-DESTRUCTIVE EVALUATION TECHNIQUES I,II(3-0)3
The non-destructive evaluation of materials and processes by penetrating radiations including sonic, magnetic, thermal, and electrical, and the abilities and limitation of each. Particular emphasis is placed upon the analysis and correlation of the interactions of these energy forms with material properties and processes. Flaw detection, process improvement, control, and monitoring; measurement of mechanical, physical, chemical and metallurgical properties. Prerequisite: senior status.

22-495 PHYSICAL METALLURGY I,II(3-0)3
A study of the theories discussed in material science as they apply specifically to mechanical deformation of materials: yielding, creep, fracture, viscoelastic and plastic deformation, etc. The effects of thermal and mechanical treatments on the above properties are considered in detail. Prerequisite: 25-295.

Primarily for Graduate Students

22-501 GRADUATE SEMINAR IN MECHANICAL ENGINEERING (1-0)1
A required weekly seminar intended to develop the oral communication skills of the student and an awareness of research within the department. Each student will present a 20-minute paper each semester.

22-511 MATRIX METHODS IN ENGINEERING MECHANICS (3-0)3
Matrix linear algebra, factorization of simultaneous equations, direct and iterative eigenanalyses, FORTRAN programming and algorithm development, solutions in structural analysis, and dynamics and stability using program MATRIX.

22-512 STRUCTURAL DYNAMICS (3-0)3
Mass, damping and stiffness matrix development, static and dynamic condensation techniques, eigensolutions using MATRIX and structural analysis programs, modal superposition, maximum response analysis, direct integration of motion equations, and non-proportional damping.

22-514 FINITE ELEMENT ANALYSIS (3-0)3
Variational methods are used to derive the finite element equations for solid and thermal problems. Direct integration and modal methods are treated along with large deformations and inelastic behavior. Prerequisites: 22-461, 22-562.

22-515 MODAL ANALYSIS I - THEORY (3-0)3
System modeling using analytical and experimental techniques, frequency response functions, single and multiple degrees of freedom curve fitting techniques, Fourier series and transform methods, DFT and FFT signal processing analysis.

22-516 MODAL ANALYSIS II - EXPERIMENTAL (3-0)3
Measurements using FFT-based modal analyzers, structural modal surveys using impact and sine sweep excitations, analytical modeling of test system, theory of estimation, complex modes, optimization of system matrices, and structural modification procedures.

22-517 EXPERIMENTAL METHODS IN VIBRATION (3-0)3
The measurement of mechanical vibration. Topics include transducer selection, transducer design, and signal conditioning. Typical measurement errors are examined and signal processing concepts are introduced.

22-518 SIGNAL PROCESSING TECHNIQUES (3-0)3
The statistical processing of random vibration data. Fourier analysis and spectral concepts are presented, as well as correlation, coherence and frequency response functions.

22-521 ADVANCED CAD/CAM (3-0)3
Fundamentals of CAD/CAM data bases, graphics manipulation and modeling. Interfacing data bases to CNC and other machines. Computer-controlled machinery, automation and robotics. Prerequisite: 22-421.

22-522 ADVANCED DESIGN METHODS IN KINEMATICS AND DYNAMICS (3-0)3
Theory and application of computer models for the analysis of mechanisms. Use of analysis packages on a CAD system. Prerequisite: 22-421.

22-541 FUNDAMENTALS OF THERMO-FLUID PROCESSES (3-0)3
Governing equations (thermodynamic, transport, and kinetic), types of models, modes of solution, data requirements, and sources. Applications to fluid flow, heat and mass transfer, and chemical reactions.

22-542 ADVANCED ENGINEERING THERMODYNAMICS **(3-0)3**
A comprehensive treatment of the first and second law. Availability, irreversibility, equilibrium, heterogeneous systems, mixtures and solution. Chemical equilibrium.

22-543 CONVECTIVE HEAT AND MASS TRANSFER **(3-0)3**
Review of conservation equations. Heat transfer in laminar and turbulent boundary layer and duct flow. Free convection. Convective mass transfer. Prerequisite: 22-541.

22-544 CONDUCTION AND RADIATIVE HEAT TRANSFER **(3-0)3**
Steady and unsteady heat conduction, analytical and numerical solutions. Radiative heat transfer between surfaces and participating media. Corequisite: 92-546.

22-545 COMBUSTION **(3-0)3**
Thermodynamics of combustion. Dynamics of premixed and diffusion flames; ignition and extinction; flame propagation; combustion of solid and liquid fuels. Fire problems. Prerequisite: 22-541.

22-546 ENERGY CONVERSION **(3-0)3**
Concepts of thermodynamics pertaining to energy conversion, and irreversible thermodynamics. Solid-state phenomena involved in conversion processes: energy forms, equations of state and energy fields. Selected topics in direct energy conversion systems.

22-547 THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS **(3-0)3**
Second law methods for pinpointing, quantifying and costing inefficiences in energy transfer and conversion systems, to improve and/or optimize system operation and design. Prerequisite: 22-541.

22-548 SIMULATION AND OPTIMIZATION OF ENERGY SYSTEMS **(3-0)3**
Mathematical modeling of energy-conversion devices and systems. Methods for optimization of system operation and design, Lagrange multipliers, search methods, and dynamic, geometric, and linear programming.

22-549 COOLING OF ELECTRONIC COMPONENTS **(3-0)3**
The methods of conduction, convection, boiling, and radiation heat transfer are applied to the cooling of electronic components. Analysis of complex heat sink arrays. Approximate methods and thermal circuit analogues are emphasized. Dimensionless heat transfer moduli. Matching of fan performance to air flow requirements. Heat pipes and cold plates.

22-551 ADVANCED DYNAMICS **(3-0)3**
Dynamics of rigid bodies and mixed mechanical, electrical, and fluid systems using both direct and the variational based methods of Lagrange equations and Hamilton's principle.

22-552 VIBRATIONS OF CONTINUOUS MEDIA **(3-0)3**
Introduction to wave propagation phenomena in continuous structures including: strings under tension, beams, plates, and elastic solids, as well as acoustic propagation in ducts, etc. The emphasis is on the physical descriptors of wave propogation and includes topics such as phase and group velocities, impedance relations between forces and displacements, the effects of damping on propagation, impedance matrix description of finite size structures, reflection and transmission of propagating waves at interfaces with adjacent structures, and transmission through periodic structures.

22-553 RANDOM VIBRATION **(3-0)3**
Random processes: probability, time and ensemble averages, correlation, and power spectra. Application to excitation and response of multiple input and output dynamic systems.

22-554 DYNAMIC SYSTEMS AND CONTROL **(3-0)3**
Matrix-based classical and modern approaches to dynamics and automatic control of hydraulic. thermal. electro-mechanical, and structural dynamic systems with multiple inputs and outputs.

22-555 FUNDAMENTALS OF NOISE CONTROL **(3-0)3**
Fundamental acoustic theory and measurement. Barriers and sound absorption for control of airborne noise, vibration isolation and damping for structure borne noise are discussed.

22-561 CONTINUUM MECHANICS **(3-0)3**
Stress and deformation in a continuum. Cartesian tensors. Fundamental laws of mechanics and thermodynamics. Application to elastic solids, Newtonian fluids, and viscoelastic materials.

22-562 SOLID MECHANICS I **(3-0)3**
The linear theory of elasticity is introduced followed by calculus of variations as a tool for developing the variational principles of mechanics. Applications in structural mechanics include the study of torsion, beams, plates, and shells. Prerequisites: 92-301.

22-563 SOLID MECHANICS II **(3-0)3**
Buckling. thermal stress. wave propagation and finite deformation. Prerequisites: 22-562,92-545. Corequisite: 92-546.

22-564 PLATES AND SHELLS **(3-0)3**
Solutions to bending, buckling, and vibration problems are obtained for rectangular and circular plates. The membrane theory of shells as well as the general theory is investigated. Solutions are obtained for a variety of practical shell problems. Prerequisites: 22-562,92-545.

22-566 THEORY OF THE INELASTIC CONTINUUM **(3-0)3**
Development of the constitutive equations governing inelastic (anelastic, viscoelastic, plastic and viscoplastic) deformations. Theorems and boundary value problems as applied to inelastic continua. Prerequisite: 22-562,92-545.

22-581 ADVANCED FLUID MECHANICS **(3-0)3**
Fundamental equations of fluid motion, kinematics, vorticity, circulation, Crocco's theorem, Kelvin's theorem. Helmholtz's vorticity laws, secondary flows. Stream function. velocity potential, and potential flows. Unsteady Bernoulli equation and gravity water waves.

22-582 VISCOUS FLOW **(3-0)3**
Derivation of Navier-Stokes equations. Examples of similarity and numerical solutions and turbulent boundary layer. Low Reynolds number flow. Prerequisite: 22-541.

22-583 ADVANCED TOPICS IN AERODYNAMICS **(3-0)3**
Application of aerodynamic principles to one of the following topics: helicopter rotor aerodynamics, rocket flight including orbital mechanics, or aircraft performance.

22-584 TWO-PHASE FLOW **(3-0)3**
Fundamental development of governing equations for one-dimensional, two-phase flow. Homogeneous flow, separated flow and drift flux model. Applications to gas-solid systems, gas-liquid systems. nuclear technology, and wave propagation in two-phase media.

22-585 TURBULENT FLOW **(3-0)3**
Concepts of turbulence. Mixing length theory. Classical turbulent boundary layer, pipe, and wake flows. Advanced turbulent models and measurement techniques. Prerequisite: 22-541.

22-586 COMPUTATIONAL FLUID MECHANICS (3-0)3
Fundamentals of finite difference schemes: stability, consistence, accuracy. Spectral and Galerkin's methods. Prerequisite: 22-541.

22-587 APPLICATION OF SPECIAL NUMERICAL METHODS IN THERMO-FLUID SYSTEMS (3-0)3
Application of state-of-the-art numerical methods to the solution of problems involving fluid flow, heat transfer, chemical reaction, and turbulence.

22-591 MECHANICAL BEHAVIOR OF MATERIALS (3-0)3
An examination of deformation mechanisms in solids and the study of such topics as brittle and ductile modes of fracture, fatigue, creep, viscoelasticity, diffusion, friction, and wear, using actual case studies of failures. Prerequisite: 22-495.

22-592 ULTRASOUND, A NON-DESTRUCTIVE EVALUATION METHOD (3-0)3
Propagation characteristics of ultrasound are developed and analyzed to indicate usefulness as a non-destructive method of evaluation. Equipment for generation, detection, and display are presented. Scientific and engineering applications using velocity and attenuation measurements are stressed.

22-594 INTRODUCTION TO FRACTURE MECHANICS (3-0)3
A first course in fracture mechanics covering topics such as brittle/ductile transitions, Griffith criterion, energy approaches, COD and plastic zone sizes, the Gurney approach, numerical methods, and the J-integral.

22-596 COMPOSITE MATERIALS (3-0)3
The mechanical behavior of orthotropic materials is reviewed. Methods of analyzing orthotropic lamina and laminated composites are introduced. Important methods of fabrication and testing of composites are covered. Other topics include environmental effects, joining, and machining.

22-597 STRUCTURAL APPLICATION OF COMPOSITE MATERIALS (3-0)3
Study of constitutive relationships for anisotropic materials, and application of these materials to structural elements such as beams, plates, and shells. Problems considered include bending, buckling, and vibrations. Prerequisite: 22-562 or 22-564,22-596.

22-598 CASE STUDIES IN COMPOSITE MATERIALS (3-0)3
A third course in advanced composite materials. Individual cases are analyzed such as bending, buckling, and vibration of specially orthotropic plates and angle ply laminates. Composite shells theory is reviewed and complex structures are studied. Prerequisites: 22-514,22-597.

22-601 SELECTED TOPICS IN MECHANICS (3-0)3
Advanced topics in mechanics not covered in the regular curriculum. Content will vary from year to year.

22-603 SPECIAL TOPICS IN SYSTEM DESIGN (3-0)3
Advanced topics in system design not covered in the regular curriculum. Content will vary from year to year.

DEPARTMENT OF NUCLEAR/ENERGY ENGINEERING

Program Coordinator: James P. Phelps

The program offers an undergraduate degree in Nuclear Engineering and graduate degrees in Energy Engineering. Facilities include extensive computer hardware and software and various experimental laboratories, including a 1 megawatt research reactor.

The New England Regional Student Program enables out-of-state New England residents to enroll in the Nuclear Engineering Department at a tuition rate that is set at 25 percent above in-state tuition rates rather than at the full out-of-state tuition rate

COURSE OF STUDY FOR NUCLEAR ENGINEERING (Bachelor of Science in Engineering)

Freshman Year

Fall Semester	
25-101 Intro. to Eng. Design	2
42-101 College Writing I	3
84-121 Chemistry I	3
84-123 Chemistry Lab I	1
92-131 Calculus BI	4
95-141 Physics I	3
96-141 Physics Lab I	1
	17

Spring Semester	
25-127 Computer Prog. FORTRAN	2
42-102 College Writing II	3
84-122 Chemistry II	3
84-124 Chemistry Lab II	1
92-132 Calculus BII	4
95-144 Physics II	3
96-144 Physics Lab II	1
	17

Sophomore Year

Fall Semester	
22-214 Eng. Mechanics	4
24-205 Intro. to Energy Eng.	3
92-231 Calculus B3	4
95-245 Physics III	3
96-245 Physics Lab III	1
H/S Elective I	3
	18

Spring Semester	
24-210 Comp. Appl. in Eng. Des.	3
22-242 Eng. Thermodynamics	3
92-234 Differential Equations	3
98-206 Intro. to Health Phys.	3
H/S Elective II	3
	15

Junior Year

Fall Semester	
22-381 Fluid Mechanics	3
24-301 Reactor Physics I	3
24-331 Nuclear Inst. I	3
92-301 Applied Math. I	3
64-200 Economic Analysis	3
	15

Spring Semester	
22-344 Heat Transfer	3
24-302 Reactor Physics II	3
80-305 Nuclear Inst. II	4
25-295 Material Science	3
H/S Elective IV	3
	16

Senior Year

Fall Semester	
24-401 Power Syst. Eng. I	3
24-403 Reactor Operations	3
24-415 Intro. to Fusion	3
Tech. Elective I	3
H/S Elective V	3
	15

Spring Semester	
24-402 Power Syst. Eng. II	3
24-404 Nuclear Eng. Design	4
Tech. Elective II	3
Tech. Elective III	3
H/S Elective VI	3
	16

University and Engineering Accreditation Requirements must be met for Humanities/Social Science (H/S) electives.

ROTC students may substitute 29-401/402 for a technical elective.

Nuclear Engineering Program (Course Prefix: 24)

24-205 INTRODUCTION TO ENERGY ENGINEERING I(2-0)2
Overview of the feasibility, environmental impact, and economics of various energy producing systems.

24-210 COMPUTER APPLICATIONS IN ENGINEERING DESIGN II(3-0)3
Study of basic numerical methods of mathematical analysis, and introduction to the concepts of a computer operating system. Emphasis on computer applications.

24-301 REACTOR PHYSICS I I(3-0)3
Review of relevant nuclear physics topics, Q-equation, kinematics, radioactive decay, and neutron cross-sections. Slowing down theory, steady state diffusion theory, and criticality of an unreflected reactor. Prerequisite: 92-234.

24-302 REACTOR PHYSICS II II(3-0)3
Multigroup diffusion theory, finite difference methods, reflected and heterogeneous reactors, reactor kinetics, reactivity feedback, fission product poisoning, reactivity coefficients, control rod theory, and computer applications. Prerequisites: 24-301,92-301.

24-320 INTRODUCTION TO SOLAR TECHNOLOGIES I(3-0)3
Survey of solar thermal systems. Space heating and water heating. Photovoltaic principles, wind systems. Biomass conversion, concentrating collectors.

24-331 NUCLEAR INSTRUMENTATION I(1-3)3
Electrical test and measurement techniques using oscilloscopes, function generators, and multimeters. Construction and test of circuits in nuclear instrumentation.

24-401 POWER PLANT ENGINEERING I I(3-0)3
Review of current and projected types of power plants for electric generation, energy production, and heat removal. Heat transfer in fuel elements and shields, thermo-hydraulics of non-boiling and boiling liquids. Particular emphasis is placed on pressurized and boiling water reactors.

24-402 POWER PLANT ENGINEERING II II(3-0)3
Continuation of 24-401. Review of First and Second Laws of Thermodynamics, analysis of cycles for power production including Rankine and Brayton cycles, heat exchanger design, analysis of standard power plant components (turbines, pumps, condensers, steam generators, and feedwater heaters), elements of power economics, evaluation of the cost of electricity.

24-403 REACTOR OPERATION AND LICENSING I(2-2)3
Start-up and operation of nuclear plants, regulations, procedures and measurements, staff requirements, the licensing process, objectives and criteria. Review of safety analysis reports, technical specifications, and codes. Each student goes through a precritical reactor checkout, critical approach, and various reactor operational measurements in the University of Lowell reactor. Prerequisites: senior standing.

24-404 POWER SYSTEMS DESIGN II(4-0)3
A group design project in which the class participates in the overall design of power plant systems, integrating the requirements of physics, control, heat transfer, thermodynamics, fuel cycle, economics, safety, siting and radiological and environmental effects. Each member of the class will be responsible for a particular aspect of the design. Prerequisites: 24-301,24-401.

24-415 INTRODUCTION TO FUSION RESEARCH I(3-0)3
Fusion reactions, the Coulomb barrier, phase space moments of the distribution function, charge, current density, pressure tensor, the Saha equation, Maxwell equations, elementary plasma theory, possible approaches to controlled fusion, methods of plasma confinement, energy balance equations for plasma, radiation losses, operational conditions, and utilization of thermonuclear neutrons. A design project is included. Prerequisites: senior standing or permission of instructor.

24-419 REACTOR OPERATOR TRAINING II(0-6)3
Training, including in-reactor experience and topical lectures given to reactor operator trainees who will undergo federal testing for a reactor operator license.

24-420 REACTOR OPERATOR TRAINING II(0-6)3
Continuation of 24-419. Upon completion of this course, the student will be given a simulated reactor operator examination, including a written test and oral test about reactor systems and a controls manipulation test, similar to the federal examination.

24-424 SOLAR SYSTEMS ENGINEERING—RESIDENTIAL II(3-0)3
Solar insolation direction, transmission, flat plate collectors, passive and active water and space heating systems, economics, design methods.

24-495 SPECIAL NUCLEAR PROBLEMS I(0-6)3
Special problems in nuclear engineering assigned to the individual student, with emphasis on modern research methods and preparation of results for publication. Prerequisite: permission of instructor.

24-496 SPECIAL NUCLEAR PROBLEMS II(0-6)3
Continuation of 24-495 for a second semester. Prerequisite: permission of instructor.

Primarily for Graduate Students

24-501,502 GRADUATE RESEARCH SEMINAR (1-0)1
Presentation and discussion by faculty, invited speakers, and graduate students of recent developments in the field of nuclear and solar engineerng, energy policy, and the financial and social costs of power. Required for all graduate students. Weekly meetings.

24-504 ENERGY ENGINEERING WORKSHOP (3-0)3
Group/individual design project, integrating many aspects of the student's engineering background, including design concepts, technical analyses, economic and safety considerations, etc. A formal report and oral presentation are required. Prerequisite: permission of instructor.

24-505 REACTOR PHYSICS (3-0)3
Advanced treatment of several topics in reactor physics, including cross sections and processing methods, development of transport theory, reduction to diffusion theory, and analyses of analytical and numerical solutions of the resultant balance equations. Prerequisite: permission of instructor.

24-506 SPECIAL TOPICS IN REACTOR PHYSICS (3-0)3
Potential topics include nodal methods, perturbation theory, data sensitivity and uncertainty analysis, fuel management and core optimization methods, noise analysis, space-time kinetics, reactor control, and reactor safety. May be repeated since topics vary. Prerequisite: permission of instructor.

24-507 REACTOR ENGINEERING AND SAFETY ANALYSIS (3-0)3
Modeling and analysis of reactor thermal-hydraulics/safety systems. Computer applications

and NRC licensing criteria. Prerequisite: permission of instructor.

24-508 SPECIAL TOPICS IN REACTOR ENGINEERING (3-0)3
Topics will deal primarily with reactor safety issues such as containment analysis, fission product release during accidents, probabilistic risk assessment, core concrete interactions, and standardized plant design. Prerequisite: permission of instructor.

24-509 SYSTEMS DYNAMICS (3-0)3
Mathematical foundation using the state-variable approach. Topics include matrix methods, Laplace and Fourier transforms, transfer functions, frequency response and stability analyses, and distributed/lumped parameter systems. Applications to thermo-fluid systems. Prerequisite: permission of instructor.

24-510 NUCLEAR FUEL CYCLE (3-0)3
Discussion of the nuclear fuel cycle, including pre-irradiation, irradiation, and post-irradiation of the fuel in a nuclear reactor. Evaluation of the components of the cost of electricity produced by a nuclear reactor. Prerequisite: 24-302 or 24-505.

24-511 ADVANCED REACTOR CONCEPTS (3-0)
General characteristics: breeding cycles and plutonium production, neutron balance, breeding ratio, and doubling time. Kinetic control and safety, sodium void and doppler coefficients. Design concepts. Prerequisite: 24-302 or 24-505.

24-512 CRITICALITY CONTROL (3-0)3
Consideration of safe practices in transportation, storage, handling, and use of fissionable materials. Effects of moderators, reflectors, and geometrics in thermal, epi-thermal, and fast assemblies. Natural and engineered safeguards are discussed. Prerequisite: permission of instructor.

24-514 WASTE MANAGEMENT (3-0)3
History of nuclear waste disposal and engineering design of disposal systems. Status of present waste and the character and quantities of future wastes. Review of disposal concepts on a generic basis. The national plan for waste disposal. Prerequisite: permission of instructor.

24-516 CONTROLLED THERMONUCLEAR FUSION I (3-0)3
Major approaches to controlled fusion. Fuel cycles, sources and diagnostics, confinement. Energy conversion, including direct collection, electromagnetic coupling and thermal cycles. Fusion blankets. Prerequisite: 24-416 or permission of instructor.

24-518 NEUTRON AND GAMMA TRANSPORT THEORY (3-0)3
Development of balance equations describing radiation transport. Analytical and numerical solution of the forward/adjoint integro-differential and integral Boltzman equations. Emphasis on discrete ordinates and Monte Carlo methods as applied to radiation shielding. Prerequisite: permission of instructor.

24-519 REACTOR OPERATOR TRAINING (0-6)3
Training, including in-reactor experience and topical lectures, given to reactor operator trainees who will undergo federal testing for a reactor operator license. Prerequisite: permission of instructor.

24-520 REACTOR OPERATOR TRAINING (0-6)3
Continuation of 24-519. Upon completion of this course, the student will be given a simulated reactor operator examination, including a written and oral test about reactor systems and a controls manipulation test. Prerequisite: permission of instructor.

24-521 FUNDAMENTALS OF SOLAR ENERGY UTILIZATION (3-0)3
Solar radiation in space and on the earth's surface. Sunshape. Intensity and flux: effect of location and orientation. Review of heat transfer. Opaque and transparent bodies. Characterization of solar collectors. A project is required. Prerequisite: permission of instructor.

24-522 NUCLEAR MATERIALS (3-0)3
Review of metals and metal oxide properties. Radiation damage in fluids, plastics, ceramics, electronics, and graphite. Hardening, embrittlement, swelling, and creep in metals. Damage mechanisms. Shielding materials. Prerequisite: permission of instructor.

24-523 NUMERICAL METHODS IN ENGINEERING ANALYSIS (3-0)3
Finite dimensional vector spaces, matrix algebra, finite difference equations and matrix iterative techniques. Applications involving the neutron diffusion and heat conduction equations. Description of the Monte Carlo and response matrix methods. Prerequisite: permission of instructor.

24-524 INTRODUCTION TO SOLAR THERMAL RESEARCH (3-0)3
Overview of solar thermal projects and concepts. Solar systems as lossy networks. Lessons learned and potential for improvement. Fuels and chemicals. Advanced concepts. A project is required. Prerequisite: 24-521, 24-527 or permission of instructor.

25-525 CONTROLLED THERMONUCLEAR FUSION II (3-0)3
Introduction to plasma physics. Particle orbit theory. The kinetic equation. Macroscopic description—static problems, waves, and instabilities. The Vlasov equation—microscopic instabilities. Transport coefficients. Prerequisite: 24-516 or permission of instructor.

24-527 SOLAR SYSTEMS ENGINEERING—COMMERCIAL AND INDUSTRIAL(3-0)3
Concentrating collectors, thermal network modeling, passive design tools, photovoltaic systems, solar cooling, daylighting, solar ponds, and economics. Prerequisite: permission of instructor.

24-529 GEOTHERMAL ENERGY (3-0)3
Systematic study of geothermal energy resources and their distribution. Economics of geothermal applications. One type of geothermal plant will be studied from concept through operation. Prerequisite: permission of instructor.

24-531,532 SELECTED TOPICS IN ENERGY SCIENCE (3-0)(3-0)6
Individual research projects in a variety of topics in nuclear, solar, or general energy engineering and technology. Emphasis is on state-of-the-art research methods in the particular field of interest. May be repeated with consent of advisor. Prerequisite: permission of instructor.

DEPARTMENT OF PLASTICS ENGINEERING

Nick R. Schott, Department Head

Professors: S. J. Chen, Aldo Crugnola, Rudolph Deanin, Stephen Driscoll, Stephen Orroth, Stephen Petrie, Nick Schott, Amad Tayebi

Associate Professors: Everett Arnold, Stephen Grossman, Jan-Chan Huang, William Kyros, Fang Lai, Robert Nunn

Assistant Professors: Stephen McCarthy

This program is designed to prepare the graduate for a professional career in the polymer industries (of which plastics is the largest), man-made fibers, rubber, coatings and adhesives. The curriculum provides a sound basis in mathematics, chemistry, process engineering, plus a full study of plastics materials, properties, plastics engineering, and product design. It includes sufficient flexibility for further specialization in areas of individual interest. Undergraduates may join the first student chapter of the Society of Plastics Engineers (SPE).

Since the program started in 1954, more than 1200 graduates have been employeed by polymer industries throughout the United States, Europe, and Asia. Major plastics producers and users recruit annually on campus. While most job openings are in product and process development or in technical service and marketing, some graduates also go into research, manufacturing, consulting, and teaching.

COURSE OF STUDY FOR PLASTICS ENGINEERING (Bachelor of Science in Engineering)

Freshman Year

Fall Semester		
25-127	Intro to Computers or	2
25-101	Intro to Eng. Design	2
42-101	College Writing I	3
84-121	Chemistry I*	3
84-123	Chemistry Lab I	1
92-131	Calculus I*	4
95-141	Physics I*	3
96-141	Fund. of Exp. Physics I	1
39-	Physical Education	1
		18

Spring Semester		
25-127	Intro. to Computers	2
25-101	Intro. to Eng. Design	2
42-102	College Writing II	3
84-122	Chemistry II*	3
84-124	Chemistry Lab II	1
92-132	Calculus II*	4
95-144	Physics II*	3
96-144	Fund. of Exp. Physics II	1
39-	Physical Education	1
		18

Sophomore Year

Fall Semester		
14-218	Analytic Mechanics	4
	or	
	Area II Elective	3
25-295	Material Science	3
26-201	Polymeric Materials I	3
26-215	Plastics Process. Lab. I	1
84-223	Organic Chemistry IB	3
84-225	Organic Chemistry Lab IB	1
92-231	Calculus III+	4
		18 or 19

Spring Semester		
26-202	Polymeric Materials II	3
26-216	Plastics Processing Lab II	1
26-246	Thermodynamics	3
84-224	Organic Chemistry IIB	3
84-226	Organic Chemistry Lab IIB	1
92-234	Differential Equations	3
14-218	Analytic Mechanics	4
or		
	Area II Elective	3
		17 or 18

Junior Year

Fall Semester		
26-301	Polymeric Materials III	3
26-313	Fluid Flow & Rheology of Polymers	3
26-315	Plastics Proc. Lab III	1
26-373	Plastics Mold Eng. I	3
26-377	Plast. Process. Eng. I	3
64-201	Economics I	3
	or	
84-339	Physical Chemistry I	2
84-341	Physical Chem. Lab I	1
		16

Spring Semester		
16-211	Fund. of Electricity	3
26-304	Process Control Systems	3
26-316	Plast. Process. Lab IV	1
26-348	Heat Tranfer	3
26-378	Plast. Process Eng. II	3
84-339	Physical Chemistry II	2
84-341	Physical Chem. Lab II	1
	or	
64-201	Economics	3
		16

* Appropriate honors courses may be substituted by qualified students.

+Technical electives must be junior level courses in engineering or science.

Senior Year

Fall Semester		Spring Semester	
26-403 Phys. Prop. of Polymers	3	26-406 Polymer Structure	3
26-411 Plastics Seminar I	1	26-412 Plastics Seminar II	1
26-415 Phys. Prop. Lab I	1	26-416 Phys. Propert. Lab II	1
Technical Elective or	3	84-404 Intro. Org. Chem. of Macro.	3
26-418 Product Design	3	84-406 Polymer Lab. II	1
84-403 Intro Phys Chem of Macro.	3	Area I Elective*	3
84-405 Polymer Lab I	1	Human Values Elective*	3
Area I Elective*	3	Technical Elective+ or	3
Area II Elective*	3	26-418 Product Design	3
	18		18

* One course in Area I or Area II should fulfill the human values requirement.

+ Technical electives must be junior level courses in engineering or science.

Combined B.S. Engineering/M.S. Engineering Degree Program In Plastics

The Plastics Engineering Department offers a program of accelerated study in order to encourage outstanding undergraduate students to continue their studies toward an advanced degree in plastics and other polymer applications. Interested students should file a Graduate School application in the junior year. Applicants for this program are not required to take the Graduate Record Examination.

Upon recommendation of the student's advisor, and with the approval of the department graduate admissions committee and the Dean of the Graduate School, the student may be admitted to graduate study during the senior year as a provisional graduate student. The student will receive a bachelor's degree at the end of the fourth year of study if all course requirements have been met. Acceptance as a matriculated graduate student is contingent upon the further recommendation of the department committee and the approval of the Dean of the Graduate School.

Students accepted in the program must satisfy all requirements of the department and the Graduate School for the Master of Science in Engineering degree.

Certain graduate or advanced undergraduate (400 level) courses taken during the senior year may be used for both the graduate and undergraduate degrees up to a total of 8 credits.

The graduate credits are taken in the senior year in the following sequence:

Fall Semester

26-601 Graduate Seminar, taken in place of 26-411 Plastics Seminar. (1 credit)
A graduate course in Plastics Engineering, taken in place of an undesignated elective. (3 credits)

Spring Semester

26-202 Graduate Seminar, taken in place of 26-412 Plastics Seminar. (1 credit)
A graduate course in Plastics Engineering taken in place of an undesignated elective. (3 credits)

In some cases, an undergraduate student may take additional graduate courses, credits for which are not applied to the minimum University requirements for the Bachelor of Science in Engineering, and apply these to the Master of Science in Engineering.

During the summer preceding the fifth year, the student, if accepted as a matriculated student in the Graduate School, will begin his or her thesis research. By the end of the fifth year the student may expect to have completed 16 credits of graduate electives and 6 credits of thesis research, in addition to the credits taken in the senior year which are applicable to the master's degree program.

Students taking full advantage of the combined program ordinarily may expect to finish the M.S. Engineering degree at the end of the fifth year of study. Actual completion will depend upon the student's course load and thesis work.

A student may be eligible for financial assistance, i.e., fellowships and teaching assistantships, during the fifth year of study, but acceptance of such assistance and the attendent responsibilities may delay the completion of the program beyond five years.

Plastics Engineering (Course Prefix: 26)

26-201 POLYMERIC MATERIALS I **I(3-0)3**
An intensive study of the many generic classes of polymeric materials. Examination of important raw materials, polymerization theory and practice, methods of manufacture, and correlation of polymer structure with engineering properties. Review of marketing principles and property/performance characterisics.

26-202 POLYMERIC MATERIALS II **II(3-0)3**
A continuation of Polymeric Materials I. Emphasis is on the thermoplastic resins and especially the engineering polymerics. Comprehensive review of product performance in its relationship to basic design principles as representative manufacturing systems. Discussion of polyblends with emphasis on related polymer chemistry, inter-and intra-molecular bonding, and fundamental processing characteristics. Outline of recent developments in thermal extreme polymeric systems. Prerequisite: 26-201 or permission of instructor.

26-211 PLASTICS MATERIAL SCIENCE **II(3-0)3**
Discussion of the historical development of polymeric materials, related classification systems, and methods of manufacture. Survey of the more prominent resin families with particular emphasis on the engineering plastics. Review of end-use applications with respect to pricing, processing and performance. (Primarily for industrial technology majors).

26-215 PLASTICS PROCESS ENGINEERING LABORATORY **I(0-3)1**
A laboratory course to study polymer processing methods. Experiments are designed so that the student will understand the theory of polymer conversion techniques by the interaction among process variables, engineering variables, and materials. Some of the conversion methods studied are extrusion, injection molding, blowing molding, thermoforming, compounding and mixing.

26-216 PLASTICS PROCESS ENGINEERING LABORATORY II **II(0-3)1**
A continuation of 26-215.

26-246 ELEMENTS OF THERMODYNAMICS **II(3-0)3**
The principles of thermodynamics, and a study of the first and second laws of thermodynamics with applications to classic systems and polymer systems. Thermodynamic properties of polymers. The concepts of entropy, reversibility, irreversibility, and availability.

26-301 POLYMERIC MATERIALS III **I(3-0)3**
A continuation of 26-201,26-202 with emphasis on engineering and specialty high performance polymers.

26-303 ADDITIVES FOR POLYMERIC MATERIALS **I(3-0)3**
Analytical review of the chemical satellites incorporated in base polymers to modify processing characteristics and inherent/physical properties. Theoretical review of reinforcements, chemical and physical compatibility of additives, plasticizer theory, thermal and oxidative stabilization/degradation mechanisms, flame retardant actions, and other important additives such as colorants, biostats, blowing agents, anti-static treatments, and impact modifiers/processing aids. Prerequisites: 26-201,26-202 or permission of instructor.

26-304 PROCESS CONTROL SYSTEMS **II(3-0)3**
Basic principles of control systems used with plastics processing equipment. Included are instrumentation, signal conditioning, data acquisition, feedback control, process monitoring, data reduction, and automation. Prerequisite: 92-234 or permission of instructor.

26-313 FLUID FLOW AND RHEOLOGY OF POLYMERS **II(3-0)3**
Statics and dynamics of Newtonian fluids. Flow in closed conduits, measurement of fluid flow, flow of suspensions, rheology of melts.

26-315 PLASTICS PROCESS ENGINEERING LAB III **I(0-3)1**
Laboratory instruction of a more advanced nature in the processing and fabrication of plastics materials. A continuation of the processing laboratory sequence, but with the emphasis on student designed experiments. Prerequisite: 26-216.

26-316 PLASTICS PROCESS ENGINEERING LAB IV **II(0-3)1**
A continuation of 26-315.

26-348 HEAT TRANSFER **II(3-0)3**
Theory and application of steady and transient heat conduction, convection, and radiation. Heat transfer in plastics processing. Heat transfer and viscous dissipation in polymeric fluids.

26-373 PLASTICS MOLD ENGINEERING I **I(2-2)3**
Introduction to the fundamentals of plastics mold and die engineering with the objective of developing overall understanding of the mold engineer's job. Emphasis is placed on the approach to mold engineering which includes the interrelationships of polymeric materials, processing, and plastics product design; mold and die design/construction; and design communications. Laboratory consists of the actual design of a mold or mold components with emphasis on mechanical drawing in design communications.

26-376 PLASTICS MOLD ENGINEERING II
Emphasis on injection and "prototype" mold design. Laboratory consists of a case study approach to lecture materials, and the design and construction of prototype molds. Computer aided design and simulation of process.

26-377 PLASTICS PROCESS ENGINEERING I **I(3-0)3**
A study of the fundamental principles of polymer processing, i.e., the conversion of the polymeric materials into useful articles. Correlation between process variables, material characteristics and parts design are studied to determine their functional relationships. Prerequisite: 26-315,26-316.

26-378 PLASTICS PROCESS ENGINEERING II **II(3-0)3**
A continuation of 26-377. Prerequisite: 26-377.

26-403 PHYSICAL PROPERTIES OF POLYMERS **I(3-0)3**
Introduction to basic mechanical properties of polymers as linear viscoelastic materials. Concepts of creep, stress relaxation, and superposition principles are emphasized. Dynamic mechanical behavior, interrelations between various properties, electrical behavior,

miscellaneous mechanical properties, optical properties. Prerequisite: senior status.

26-406 POLYMER STRUCTURE **II(3-0)3**
The fundamental relationships among molecular structure, properties and end-use applications of plastics materials are explored in detail. Molecular structural features include chemical composition, molecular size and flexibility, intermolecular order and binding, and supermolecular structure. Properties include processability, mechanical, acoustic, thermal, electrical, optical, and chemical properties, price, and balance of properties. Applications include rigid solids, flexible solids, foams, film, and non-plastic applications.

26-407 PLASTICS INDUSTRY ORGANIZATION **I(3-0)3**
Economics of producing plastics raw materials and converting them into end products, from research and development to plant construction, operation, and marketing. Market analysis of plastics production, processing, and consumer patterns, commercial development, sales, and technical service. Organization of the plastics industry for research and development, specialty and commodity production, profit, and growth. Prerequisite: permission of instructor.

26-409 SENIOR RESEARCH IN PLASTICS **I(1-6)3**
Individual research projects in plastics chemistry, properties, processing, products, and industry organization. Students review the existing literature, obtain materials and equipment, plan and carry out research programs, and submit final reports for publication. Prerequisite: permission of instructor.

26-410 SENIOR RESEARCH IN PLASTICS **II(1-6)3**
Continuation of 26-409.

26-411 PLASTICS SEMINAR I **I(1-0)1**
A close study of the literature on a selected topic or topics in plastics engineering.

26-412 PLASTICS SEMINAR II **II(1-0)1**
Continuation of 26-411.

26-413 SENIOR PROJECTS I **II(0-2)1**
Assignment of senior projects designed to develop ability to organize and conduct investigations of materials performance and processing techniques.

26-414 SENIOR PROJECTS II **I(0-2)1**
Continuation of 26-413.

26-415 PHYSICAL PROPERTIES LABORATORY I **I(0-3)1**
Measurement of mechanical properties in tension, compression, shear, and flexure; dielectric constant and dissipation factor; thermal behavior under stress; melt rheology.

26-416 PHYSICAL PROPERTIES LABORATORY II **II(0-3)1**
Continuation of 26-415.

26-417 PLASTICS PROCESSING TECHNIQUES **I(1-2)1**
A study of the manufacturing techniques used in the plastics industry. Emphasis is placed on extrusion, injection molding, blow molding, compounding, and thermoforming. Correlation between the properties of a material and its processability are investigated. Not open to students majoring in plastics engineering.

26-418 PRODUCT DESIGN **I,II(3-0)3**
Theoretical principles and sound engineering practice involved in the design of new end products made from polymers, applying a total systems approach to the balance among product design, choice of materials, tool design, and process techniques as they affect com-

petitive choice for commercial success. A semester project is required.

26-420 PLASTICS IN ELECTRICAL ENGINEERING **II(3-0)3**
Elective course in applied polymer science as related to current potential electrical engineering applications. Attention is devoted to polymeric materials and reinforced plastics, principal physical properties, processing methods, manufacturing considerations and testing methods. Review of practical applications with emphasis on price, processability, and performance.

26-421 INDUSTRIAL SEMINAR I **I(1-0)1**
A series of topics relating to plastics materials, processes, and engineering, presented by representatives of the plastics industry. Course is intended to utilize the expertise of industry in specific areas of interest.

26-422 INDUSTRIAL SEMINAR II **II(1-0)1**
Continuation of 26-421.

26-425,426 RHEOLOGY AND CHARACTERIZATION PRACTICUM **I,II(2-3)3**
Practical review of theoretical concepts of rheological measurements with practical applications of experimental techniques. Emphasis will be on the viscoelastic properties of polymer solutions, melts, and solids and their correlation with theoretical dynamic mechanical behavior.

26-431 SURVEY OF MAN-MADE FIBERS AND FIBER STRUCTURES **I(3-0)3**
Discussion of the basic problems encountered in the man-made fiber industries, including fiber and fiber structure properties, processing, utilization, and various aspects of current research. Recent advances and projected developments.

26-445 METHODS OF EXPERIMENTAL ANALYSIS **I(3-0)3**
Methods of efficient design and analysis of scientific and industrial processing experiments. Classical versus factorial experiments, statistical distributions and statistical inference, single and multifactorial analysis, and interaction correlation and regression.

26-451 SELECTED TOPICS IN PLASTICS **I(3-0)3**
Topics in various fields of plastics. Content may vary from year to year so that students may by repeated enrollment acquire a broad knowledge of contemporary plastics.

26-452 SELECTED TOPICS IN PLASTICS **II(3-0)3**
Continuation of 26-451.

Primarily for Graduate Students but open to undergraduates with permission of instructor. Courses marked with an asterisk (*) will be offered only if there is sufficient enrollment.

26-502 NEW PLASTICS PROCESSING TECHNIQUES* **(3-0)3**
Critical examination of new plastics processing techniques appearing in the research literature and being commercialized in the plastics industry.

26-503 MECHANICAL BEHAVIOR OF POLYMERS **(3-0)3**
Mechanical properties of bulk polymers. Linear viscoelasticity, creep, relaxation, and dynamic and stress/strain response phenomena. Principles of time/temperature superposition. Rubber elasticity. Failure behavior of polymeric materials.

26-504 PHYSICAL PROPERTIES OF POLYMERS* **(3-0)3**
Polymers as linear viscoelastic materials. Creep, stress relaxation, superposition, dynamic mechanical behavior, electrical behavior, miscellaneous mechanical properties, optical properties, transport properties.

26-506 POLYMER STRUCTURE, PROPERTIES, AND APPLICATIONS (3-0)3
Relationships between polymer structure (chemical composition, molecular weight and flexibility, intermolecular order and bonding, and supermolecular structure) and practical properties (mechanical, acoustic, thermal, electrical, optical, and chemical), and their applications.

26-507 PLASTICS INDUSTRY ORGANIZATION (3-0)3
Economics of producing plastic raw materials and converting them into end products, from research and development to plant construction and marketing. Market analysis of plastics production, processing, and consumer patterns; and commercial development, sales, and technical service. Organization of the plastics industry for research and development, specialty and commodity production, profit, and growth.

26-509 PLASTICS PROCESSING THEORY I (3-0)3
Principles of heat transfer, rheology, mixing, crystallization, and chemical reactions involved in the processing of plastics, and their applications of plastics process engineering.

26-510 PLASTICS PROCESSING THEORY II (3-0)3
A continuation of Theory I using the transport phenomena approach to analyze and describe plastics conversion processes.

26-511 POLYMER BLENDS AND MULTIPHASE SYSTEMS* (3-0)3
Physical, mechanical, and thermal properties, preparation, and testing of polymer blends, alloys, and multiphase systems. Thermodynamic theories and experimental determination of miscibility of polymer blends. Structure property relationships for multiphase systems and interpenetrating networks.

26-512 PLASTICS FOAMS* (3-0)3
Preparation, structure, and properties of plastics foams. Practical systems in development and production. Properties, applications, and markets for plastics foams and products made from them.

26-513 NEW PLASTICS MATERIALS* (3-0)3
Critical examination of the new plastics appearing in the research literature and being field-tested for commercialization in the plastics industry.

26-516 COMPOSITE MATERIALS (3-0)3
The potential of composites as a class of materials, and the uniqueness of the mechanical/physical properties realizable. Fundamental concepts underlying those properties, with particular emphasis on fibrous reinforced plastics. Survey of matrices, reinforcements, and prediction of composite properties from a knowledge of the properties and topology of constituent materials. Factors affecting ultimate strength and fatigue behavior.

26-518 PRODUCT DESIGN (3-0)3
Theoretical principles and sound engineering practice involved in the design of new end products made from polymers, applying a total systems approach to the balance among product design, choice of materials, tool design, and process techniques as they affect competitive choice for commercial success. A semester project is required.

26-521 POLYMERIZATION ENGINEERING* (3-0)3
Engineering design of equipment and plants for polymer production. Processes for production of each of the major commercial polymers.

26-523 PLASTICS PROCESS DESIGN, ANALYSIS, AND SIMULATION (3-0)3
Calculations and simulations of batch and continuous processes. Dimensional analysis. Ther-

modynamic properties of thermoplastics. Enthalpy, heat capacity, sensible heat, heat of fusion, and heat of reaction. Scale-up and modeling of processes.

26-524 PROCESS ANALYSIS, INSTRUMENTATION AND CONTROL* (3-0)3
Industrial instruments for measurement and control of plastics processes. Design of experiments. Analysis of plastics forming operations. Dynamic testing techniques. Automatic plastics process control. Modeling and process simulation in extrusion and injection molding. Data acquisition systems.

26-525 PROCESSING OF SYNTHETIC FIBERS AND STRUCTURES* (2-2)2
An introduction to systems utilized in the processing of synthetic fiber structures, to include drawing, winding, texturing, staple fiber production, blending, static control, dyeing and finishing. The effect of these mechanical, physical, and chemical processes on the resultant fiber and fiber structure behavior.

26-526 ADVANCED PROCESSING OF SYNTHETIC FIBERS AND FIBER STRUCTURES* (3-0)3
A continuation of 26-525 to include a more detailed view of the processes and effects involved.

26-527 MECHANICS OF FIBROUS STRUCTURES* (3-0)3
Characteristics of fibers affecting performance of conventional and non-conventional fibrous structures. Design considerations and mechanical behavior of twisted, knitted, woven, braided, and nonwoven fibrous materials.

26-528 KNITTED AND NON-CONVENTIONAL FIBER STRUCTURES (2-2)3
Non-woven materials and unusual fiber structures such as needle-punched, stitch bonded, and ultrasonicically welded structures. Problems are assigned for laboratory evaluations and written reports. Oral presentations are required.

26-529 FIBER EVALUATION* (2-2)
Basic mechanical tools, techniques, and their utilization by industry for research, development, production control, and end use evaluation. Moisture equilibrium and rates of change relations, basic fiber, yarn, and structure dimensions. Introduction to the determination and evaluation of the stress-strain-time properties of fibers and fiber structures. Wear and abrasion are among the topics considered.

26-530 INTRODUCTION TO FIBER MARKETING, MANAGEMENT AND PLANT ORGANIZATION* (3-0)3
An introduction to basic principles in the marketing, management, and plant organization of synthetic fibers. Consideration of distribution channels, costing, sales forecasting, management recruiting, and machinery layouts.

26-531 SURVEY OF SYNTHETIC FIBERS AND FIBER STRUCTURES (3-0)3
General discussion of the basic problems encountered in the synthetic fiber industries, including fiber and fiber structure properties, processing, utilization, and various aspects of current research. Recent advances and projected developments.

26-532 ADHESIVES AND ADHESIONS* (3-0)3
Adhesive joining of engineering materials. Surface chemistry, theories of adhesion and cohesion, joint design, surface preparation, commercial adhesives, rheology, equipment, testing, service life, and reliability.

26-533,534 COATINGS SCIENCE AND TECHNOLOGY* (3-0)(3-0)6
Polymers, pigments, solvents, and additives used in coatings. Methods of polymerization, formulation, application, and testing. Substrates and applications.

26-535 RUBBER* **(3-0)3**
Polymerization and compounding of the commercial elastomers. Properties and test methods. Leading applications and methods of processing.

26-536 RHEOLOGY OF COATINGS* **(3-0)3**
Rheology of polymer melts, solutions, latexes, and pigment dispersions, and their application to coatings and adhesives.

26-537 ENGINEERING PROPERTIES OF PLASTICS* **(3-0)3**
Theoretical basis and practical significance of the mechanical, thermal, electrical, optical, and chemical properties of plastic materials. Importance of engineering properties in material development and selection and in product design.

26-540 COMMERCIAL DEVELOPMENT OF POLYMERIC MATERIAL SYSTEMS*(3-0)3
The concepts of industrial marketing will be reviewed for research, pricing strategies, and product planning for market segmentation, and place (distribution)-promotional activities. Topics will include creating a demand, selling, and servicing base resins and additives.

26-541 COMPUTER APPLICATIONS* **(3-0)3**
An introduction to microprocessor programming and interfacing. Programming includes logic operations, branch and jumps, and subroutines. Interfacing includes input and output, data acquisition systems, and controller design.

26-543,544 SURVEY OF PLASTICS MATERIALS **(3-0)(3-0)6**
Descriptive course centering on the historical development of polymeric systems, their synthesis, structure, properties, and applications. A brief discussion on the typical additives employed to make plastics molding compounds is included. Not open to undergraduate plastics students.

26-545 METHODS OF EXPERIMENTAL ANALYSIS* **(3-0)3**
Methods of efficient design and analysis of scientific and industrial processing experiments. Classical versus factorial experiments, statistical distributions, and statistical inference, single and multifactorial analysis, interaction, correlation, and regression.

26-546 MIXING IN PLASTICS PROCESSING* **(3-0)3**
Solids mixing, mixing in viscous fluids, admixing, concept and techniques of residence time distribution, continuous and batch processes, improvement of extrudate quality, scale-up and theory of similarity, dispersion and distributive mixing, mixing, and heat transfer.

26-547 MATHEMATICAL TECHNIQUES FOR PLASTICS ENGINEERS **(3-0)3**
Use of vector and tensor analysis, matrices and determinants, vector differential calculus, Laplace and Fourier transforms, power series, partial differential equations, and numerical analysis in plastics engineering calculations.

26-548 NUMERICAL TECHNIQUES FOR PLASTICS ENGINEERS* **(3-0)3**
Use of numerical methods in the solution of problems concerning rheology, heat transfer, diffusion, and viscoelastic theory. Topics include solutions to ordinary differential equations, simultaneous linear equations, finite difference methods, finite element methods, plotting, linear regression, linear interpolation, curve fitting, and optimization techniques.

26-549 NYLON PLASTICS* **(3-0)3**
Plastics applications for nylon have become extensive and this course traces the development of the first engineering thermoplastic. A chronological sequence from monomer synthesis to polymerization, characterization, processing, properties, and applications. Prerequisites: 84-223,224.

26-550 PLASTICS SYNTHESIS* **(3-0)3**
Examination of all types of reactions used to synthesize plastic materials. Kinetic features of step, chain, and ring-opening polymerizations, their scope and utility for commercial production. Prerequisites: 84-223,224.

26-551 POLYMER SOLUTION SYSTEMS* **(3-0)3**
Thermodynamics of polymer solutions. Polymer blends. Devolatilization. Diffusion and rheological properties of polymer solutions. Gel permeation chromatography and related polymer characterization methods.

26-552 DESIGN OF POLYMER PROCESSING MACHINERY **(3-0)3**
Hydraulics, pneumatics, machine logic, drives, pumps, motors, heating and cooling, barrel and screw combinations, mechanical design, quick mold change, robots, and interfacing.

26-555,556 RHEOLOGY AND CHARACTERIZATION PRACTICUM* **(2-3)(2-3)6**
Review of theoretical concepts of rheological measurements with practical applications of experimental techniques. Emphasis is on the viscoelastic properties of polymer solutions, melts and solids and their correlation with theoretical dynamic mechanical behavior.

26-557 COMPOSITES FABRICATION I **(2-2)3**
Introduction to resins and reinforcements. Fabrication of thermoset composites. Hand lay-up, vacuum bagging, autoclaving, compression molding, rheological testing. Design concepts, product management, and quality control.

26-558 COMPOSITES FABRICATION II **(2-2)3**
A continuation of 26-557 with emphasis on a semester project on design, processing, and economics of composites.

26-559 ELEMENTS OF PACKAGING **(3-0)3**
Packaging methods, materials, and container designs. Analysis of container manufacturing methods for paper, plastics, cans, cardboard, and their specific properties.

26-583 RESEARCH METHODOLOGY* **(3-0)3**
A systematic evaluation of the techniques used in research and development. Experimental data are analyzed and plotted using a mathematical approach. Creative thinking, problem solving, and student presentation of data are stressed. Extensive reading and analysis of research papers, and defense of the analysis are required.

26-585,586 COMPUTER AIDED ENGINEERING AND DESIGN* **(3-0)(3-0)6**
Design of plastic components and molds. Finite element programs to perform linear and nonlinear stress analysis. MOLDFLOW program for detailed mold design. Prerequisite: 22-421.

FACULTY OF THE COLLEGE OF ENGINEERING

OFFICE OF THE DEAN

Aldo Crugnola, A.B., M.S., Sc.D., Dean

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John W. McKelliget, Assistant Professor, Mechanical and Energy Engineering; B.Sc., Exeter University; Ph.D., Sunderland Polytechnic

Rezene G. Medhani, Assistant Professor, Civil Engineering; B.S., University of Addis Ababa (Ethiopia); M.S., Ph.D., University of Oklahoma

Alan Mironer, Professor, Mechanical and Energy Engineering; B.M.E., Rensselaer Polytechnic Institute; M.Eng., Yale University; Ph.D., Syracuse University

Nancy T. Miu, Associate Professor, Industrial Technology; M.S.E.E., North Dakota State University; B.S.E.E., National Taiwan University

William B. Moeller, Professor, Civil Engineering; B.S.,Villanova University; M.S., Ph.D., University of Connecticut; P.E.

James A. Moore, Associate Professor, Mechanical Engineering; B.S.M.E., Rensselaer Polytechnic Institute, M.S., Ph.D., M.E., Massachusetts Institute of Technology

Harry E. Moses, Associate Professor, Electrical Engineering; B.S., M.S., University of Michigan; Ph.D., Columbia University

Paul J. Murphy, Associate Professor, Electrical Engineering; B.S., M.S., Massachusetts Institute of Technology, P.E.

Eugene E. Niemi, Jr., Professor, Mechanical and Energy Engineering; B.S., Boston University; M.S., Worcester Polytechnic Institute; Ph.D., University of Massachusetts; P.E.

Robert E. Nunn, Associate Professor, Plastics Engineering; B.Sc., London University, D.I.C., Imperial College, Ph.D., London University

John C. O'Callahan, Professor, Mechanical and Energy Engineering; B.S., M.S., Ph.D, Northeastern University; P.E.

Stephen A. Orroth, Jr., Professor, Plastics Engineering; B.S., M.S., Lowell Technological Institute

Robert E. Parkin, Associate Professor, Electrical Engineering; B.Sc., University of London; Ph.D. and D.I.C., Imperial College, University of London

Martin A. Patt, Associate Professor, Electrical Engineering; B.S., Northeastern University; S.M., Massachusetts Institute of Technology

Stephen Petrie, Professor, Plastics Engineering; B.S., Lowell Technological Institute, M.S., Lowell Technological Institute, Ph.D., University of Connecticut

Arthur Petrou, Assistant Professor, Mechanical and Energy Engineering; B.S., University of New Hampshire; M.S., Northeastern University; P.E.

James P. Phelps, Professor, Mechanical and Energy Engineering; B.S., University of Maine, Ph.D., Michigan State University

Donald S. Pottle, Associate Professor, Industrial Technology; M.S.E., B.S.E., Northeastern University; P.E.

James E. Powers, Professor, Electrical Engineering; B.S., M.S., Lowell Technological Institute

Kanti Prasad, Associate Professor, Electrical Engineering; B.S., Agra University (India); B.E., University of Roorkee; Ph.D., University of South Carolina

Craig G. Prohazka, Assistant Professor, Electrical Engineering; B.S., Rensselaer Polytechnic Institute; M.S., M.I.T., Ph.D., University of Massachusetts

Tenneti C.K. Rao, Assistant Professor, Electrical Engineering; B.S. Andhra University; B.S., M.E., Ph.D., Indian Institute of Science, Bangalore (India)

A. Mark Ratner, Assistant Professor, Civil Engineering; B.E., M.E., Stevens Institute of Technology; M.S., Cornell University; Ph.D., Stevens Institute of Technology, P.E.

Bodo W. Reinisch, Professor, Electrical Engineering; M.S., University of Freiburg (Germany); Ph.D., University of Lowell

Struan R. Robertson, Associate Professor, Mechanical and Energy Engineering; B.S., M.S., Clarkson College of Technology; M.S., Ph.D., Rensselaer Polytechnic Institute

Kenneth L. Rogers, Professor, Mechanical and Energy Engineering; B.S., University of Maine; P.E.

James H. Rome, Associate Professor, Electrical Engineering; B.S., M.S., Ph.D., University of Michigan

Ziyad Salameh, Assistant Professor, Electrical Engineering; M.Sc., Ph.D., University of Michigan

Gary S. Sales, Associate Professor, Electrical Engineering; B.S., Brooklyn College; M.S., Ph.D., Pennsylvania State University

Dominick A. Sama, Professor, Chemical Engineering; S.B., S.M., Sc.D., Massachusetts Institute of Technology

Nick R. Schott, Professor, Plastics Engineering; B.S., University of California, Berkeley; M.S., Ph.D., University of Arizona

Burton A. Segall, Professor, Civil Engineering; B.C.E., Polytechnic Institute of Brooklyn, M.S., M.P.H., University of North Carolina; Ph.D., New York University; P.E.

John J. Sewell, Associate Professor, Civil Engineering; S.B., C.E., Massachusetts Institute of Technology

James R. Sheff, Professor, Mechanical and Energy Engineering; B.S., University of Colorado; M.S., Ph.D., University of Washington

Dudley G. Shepard, Professor, Mechanical and Energy Engineering; B.S., Yale University; M.S., Sc.D., Massachusetts Institute of Technology

V. Edward Simms, Jr., Instructor, Industrial Technology; B.S., Geneva College; M.B.A., Worcester Polytechnic Institute

Karl J. Sladek, Professor, Chemical Emgineering; B.S., M.S., Sc.D., Massachusetts Institute of Technology

Steven M. Slater, Assistant Professor, Chemical Engineering B.S., M.S., Sc.D., Massachusetts Institute of Technology

Stephen J. Spurk, Associate Professor, Electrical Engineering; B.S., Merrimack College; M.S., University of New Hampshire

Louis C. Tartaglione, Associate Professor, Civil Engineering; B.S., Manhattan College; M.S., University of Connecticut; P.E.

Amad Tayebi, Professor, Plastics Engineering; B.S., Alexandria University (Egypt); M.S., M.E., Sc.D., Massachusetts Institute of Technology

Ahn Tran, Professor, Electrical Engineering; B.Sc., National Taiwan University; M.S., Ph.D., University of Rhode Island

Robert J. Tuholski, Associate Professor, Industrial Technology; B.S., Fitchburg State College; M.Ed., Ph.D., University of Maryland

Joseph Ustinowich, Instructor, Mechanical and Energy Engineering; B.S.M.E., Lowell Technological Institute; M.S.M.E., University of Lowell

Peter S. Vail, Assistant Professor, Industrial Technology; B.S., Ch.E., Lehigh University; M.B.A. Economics, Xavier University

David P. Wade, Associate Professor, Electrical Engineering; B.S., Lowell Technological Institute; M.S. Northeastern University

Fahd G. Wakim, Associate Professor, Electrical Engineering; B.S., American University of Beirut; M.A., Ph.D., University of Texas

John W. Walkinshaw, Associate Professor, Chemical Engineering; B.S., M.S., M.S., Lowell Technological Institute; Ph.D., Victoria University of Manchester (England)

Jay A. Weitzen, Assistant Professor, Electrical Enginering; B.S.E.E., M.S.E.E., Ph.D., University of Wisconsin

John R. White, Assistant Professor, Mechanical and Energy Engineering; B.S., University of Lowell; M.S., University of Tennessee

David A. Wunsch, Associate Professor, Electrical Engineering; B.E.E., Cornell University; S.M., Ph.D., Harvard University

Woon-Shing Yeung, Associate Professor, Mechanical and Energy Engineering; B.S., University of Lowell; M.S., University of California; Ph.D., University of California

Yakov M. Zilberberg, Associate Professor, Mechanical and Energy Engineering; M.S., Technological Institute of Food and Refrigeration Industry (USSR); Ph.D., University of New Hampshire

Mahmoud Wagby, Assistant Professor, Electrical Engineering; M.S., Cairo University; Ph.D., Kansas State University

COLLEGE OF HEALTH PROFESSIONS

Eleanor Forsley Shalhoup, Dean
Susan Wozenski, Assistant Dean

The faculty of the College of Health Professions believe that each individual has the right to achieve and maintain an optimal level of health. As a response to society's need for individuals to exercise this right, the College of Health Professions provides programs to prepare health professionals on both an undergraduate and graduate level. The undergraduate programs prepare the students in their chosen health profession. The graduate programs provide greater depth in knowledge, attitudes, and skills necessary for leadership in the health professions.

These programs are based on the belief that preparation for professional practice requires the acquisition of theoretical knowledge and professional attitudes and skill and the oportunity to utilize these in supervised clinical and community settings. The integration of didactic and practicum experience encourages the development of professional attitudes, values, and skills.

Members of the College of Health Professions, through education, research, and community service, collaborate with health care professionals and consumers to assist in meeting the changing health needs of society.

GOALS OF THE COLLEGE OF HEALTH PROFESSIONS

The College of Health Professions:

1. Prepares professionals in various health disciplines.
2. Provides the students of each health discipline with a theoretical knowledge base and the opportunity to practice professional competencies in supervised practicums in a variety of settings.
3. Fosters personal growth and the development of professional attitudes and values.
4. Prepares students to provide leadership through education, research, and service in meeting the changing health needs of society.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Health Professions is organized into five departments and is administered by a dean and an assistant dean who are assisted by an executive committee. Each of the departments is responsible for developing programs of studies and course offerings. Although the faculty of the college has overall responsibility for all academic policies of the college, the academic standards committee is responsible for enforcing the academic standards of the college and also serves as a review body for suspended students seeking readmission with probationary status. In addition, each department has its own professional review committee which evaluates appeals from students who have not met the criteria for retention in their specific program. Such appeals to professional review committees may be submitted only once and all decisions of these committees are final.

Executive Committee

Eleanor F. Shalhoup, Dean
Susan Wozenski, Assistant Dean

Alease Bruce, Chairperson, Clinical Laboratory Sciences
Karen Lorentzen, Chairperson, Health
May Futrell, Chairperson, Nursing
Joseph Dorsey, Chairperson, Physical Therapy
Claire Chamberlain, Chairperson, Physical Education

Advisory Councils

Each major of the College of Health Professions has an advisory council comprised of professionals distinguished in their fields.

BACCALAUREATE DEGREE PROGRAMS

The College of Health Professions offers undergraduate programs leading to the degree of Bachelor of Science. Degree programs are offered in Clinical Laboratory Sciences, Health Education, Nursing, and Physical Therapy (until the class of 1991, after which it will be a graduate program only). For information concerning graduate offerings of the college, see the Graduate School Catalogue.

The course requirements for undergraduate programs of the college have been determined by specific professional objectives and are subject to the recommendations of the various professional accrediting associations. Each course of study provides a basic general education in the sciences, the psycho-social areas, and the humanities; a comprehensive introduction to the health professions; upper division professional courses; and clinical or teaching experiences in one or more community health agencies or schools. Candidates for the Bachelor of Science degree in the College of Health Professions must comply with the University core requirements and with the rules and regulations of the College of Health Professions. The Univerisity core requirements are described elsewhere in this publication under the heading "Academic Policies".

Candidates for degrees in the College of Health Professions may be permitted to elect a second academic major or a minor in another college provided that all curriculum requirements of the College of Health Professions can still be satisfied. Election of a second major or minor may require an extension of the normal four-year period of undergraduate study for all but the unusual student.

GENERAL COLLEGE REQUIREMENTS

Each candidate for a baccalaureate degree in the College of Health Professions must satisfy the general University requirements for graduation, complete all courses and credits as specified by the specific program of study, and meet the specific academic requirements of the College of Health Professions as specified in this section.

Retention and Continuance in College Programs

Irrespective of the classification policies of the University, students shall not be admitted to professional courses of the College unless they have satisfactorily completed all courses which are specified in their programs of study for the first three semesters and they have achieved a cumulative grade-point average of 2.50 or better for all such courses. Students enrolled in clinical laboratory sciences, nursing, and physical therapy programs also are required to achieve at this time a cumulative grade-point average of 2.50 or better in their required physical and biological science courses.

To qualify for continued matriculation in programs of the College of Health Professions, all students must maintain on-going cumulative averages of 2.50 or better by achieving the following averages at the end of the second semester of the sophomore year and at the end of each semester thereafter: (1) a semester average of 2.50 or better, (2) not less than a grade of "C" in any professional major course and (3) a semester average of 2.50 or better for professional courses attempted in the major. Students enrolled in clinical laboratory sciences, nursing, and physical therapy programs must maintain a cumulative grade-point average of 2.50 or better in their required physical and biological science courses. Students who fail to satisfy these requirements will be dropped from their respective programs. Such students may seek reinstatement to programs by filing a petition with the professional review committee of their department. Students whose petitions for reinstatement are denied may seek transfer to another college within the University if they qualify under University policies as students with satisfactory academic standing. Students who do not qualify for such standing are dismissed from the University at the time they are dropped from the College of Health Professions and are ineligible for readmission as probationary students in the College of Health Professions

All students in the College of Health Professions must demonstrate a state of emotional and physical health which will enable them to provide safe, competent practice in their chosen professional field. In special cases, at the request of the professional review committee of the student's major department, an individual may be required to present statements of physical and/or mental health from appropriate physicians or psychiatrists who are fully licensed by the Commonwealth of Massachusetts. On the basis of a review of such statements, the professional review committee may recommend to the chairperson of the student's major department that the individual be denied admission to or continuance in the major program.

Appeals Procedure for Reinstatement

Any student who has been denied continuance in his or her major, or any student who has been dropped from a major for non-academic reasons concerning emotional and/or physical health, may submit a written petition, in response to the letter of notification received, to the appropriate professional review committee for re-evaluation of his or her record for the purpose of reinstatement. This petition must be received no later than the date specified in the letter of notification and may be submitted only once. In making recommendation for reinstatement, the professional review committee may recommend to the faculty speicfic requirements which the student must satisfy as a condition of his or her reinstatement. The faculty will vote to accept or reject the request for reinstatement and will forward to the department chairperson and the dean its recommendations together with a statement of requirements which a reinstated student must satisfy as a special condition of his or her reinstatement and continued matriculation. A student who has been dropped from his/her program after having been reinstated may not petition again for reinstatement.

Academic Advising

Each student in the College of Health Professions is assigned an academic advisor. Prior to each registration period, students should meet with their advisors to discuss selection of courses required by their academic programs.

Students who fail to avail themselves of this opportunity and who register for incorrect courses may find it necessary to extend their period of study. All seniors must consult with their advisors prior to the established University deadline for filing program of study forms with the office of the dean. The program of study summarizes a senior's status with respect to requirements of the curriculum and grade-point averages and insures that all stated requirements for graduation are satisfied.

Declaration of Program and Change of Program

Students entering the College of Health Professions are advised to declare a major at the time of admission. Students interested in the health professions but who are unsure of a specific major may be admitted to the college as "undeclared health" students. Subsequent selection of a major by "undeclared health" students may be limited to health education due to non-availability of spaces in either clinical laboratory sciences, nursing, or physical therapy programs.

All students are required to declare a major prior to the beginning of second semester of the sophomore year. Consequently, no student may retain the status of undeclared student later than the semester in which he or she has earned 45 credits. Whenever a student makes a declaration of major, he or she is required to file an official notification with the office of the registrar.

Students desiring to change their professional program within the College of Health Professions must secure the approval of the chairperson of the appropriate department. Students transferring to another major outside the College of Health Professions must apply for intercollegiate transfer. All changes of program require official notification of the office of the registrar. Students who change their programs within the College of Health Professions after the first semester of the sophomore year should expect possible additional course work beyond the minimum degree requirements and extension of the normal four-year period of study.

Transfer Policies

Qualified students may transfer into degree programs of the College of Health Professions from other colleges of the University provided they meet the requirements as stated. Irrespective of any previous recognition by the office of admissions or by other colleges of the University, a student transferring from another college of the University to the College of Health Professions must meet prerequisites and academic criteria for admission to programs of the college.

Students who contemplate transferring to one of the health professions majors of the college are advised that admission to the college is competitive and requires, as a minimum, the achievement of a cumulative grade-point average of 2.50 on a 4 point scale for all previous course work attempted. In addition, applicants for clinical laboratory sciences, nursing, and physical therapy programs are also required to have achieved a minimum of 2.50 in their science courses.

Transfer from Other Institutions

Courses transferred from other institutions are initially evaluated by the office of admissions in terms of general University requirements. When students are admitted to the University, they are also evaluated by the professional department in terms of college and program requirements. Courses which are transferred to the University under provisions of the Commonwealth Transfer Compact and which are not equivalent to those of the College of Health Professions or as unrestricted elective courses will be listed on the student's permanent record card but will not apply to the minimum degree requirements. In the event that a student who has transferred to the University under the Commonwealth Transfer Compact subsequently makes an intercollegiate transfer to the College of Health Professions, all previously completed courses, including transferred courses from the compact institution, will be re-evaluated in terms of their applicability to degree requirements of the College of Health Professions.

The applicability of grades received in transferred courses for the determination of the grade-point average of the student's major at the University of Lowell is determined by policies of each of the colleges. The policy of the College of Health Professions is to count such grades for the purpose of determining the student's grade-point average in his or her professional major.

Repetition of Transferred Courses

A student who has been granted transfer credit, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred when the competence of the student has been demonstrably inadequate. Permission to repeat a transferred course is granted by filing an academic petition form through the office of the college dean. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

Intercollegiate Transfer to the College of Health Professions

Students wishing to transfer from another college of the University, or from baccalaureate continuing education programs of the Evening School, must file a petition, together with a transcript of their permanent record cards, with the appropriate chairperson and the dean of the College of Health Professions by November 1 for spring semester transfer and by April 1 for fall semester transfer. Students should refer to University policies concerning intercollegiate transfer "Academic Policies: Change of Major with Intercollegiate Transfer" for further procedural details. Records of students who are approved for transfer are reviewed by the Office of the Dean and, irrespective of grades previously received in other college programs, all courses which may not be applied to college or program requirements are deleted from the student's cumulative grade-point average.

Readmission Policies

Students who are readmitted into their major in the College of Health Professions must comply with the current program requirements of that major. Year of graduation based on the student's previous matriculation date becomes null and void on readmission.

Special College Requirements

All students are expected to demonstrate behavior that is generally accepted as professional. All students must demonstrate proof of purchase of professional liability insurance at the beginning of their clinical experience. For physical therapy students, this will be at the beginning of the sophomore year. For clinical laboratory sciences, health education, and nursing students, this will be at the beginning of the junior year. Students are billed for this insurance by the business office, but in case of error or omission, students are advised that they must assume personal responsibility for their coverage. The professional liability insurance is in the amount of $1,000,000/$3,000,000 aggregate.

In order to participate in the clinical portion of the upper-division curriculum, all College of Health Professions students are required to be aware of their rights and responsibilities under the Massachusetts Right to Know Law. All students must supply documentation that they have completed a basic CPR course prior to entering their first clinical course. Thereafter, current CPR documentation must be presented annually for departmental approval. Each student must provide evidence that he or she is free of tuberculosis by presenting a skin test or x-ray report before enrolling in any clinical or apprentice teaching course. In addition, nursing and physical therapy majors must present a report of a complete physical examination before senior clinical experiences are scheduled. These reports are to be submitted to the University health office. Students are advised to consult department chairpersons for additional details.

Each clinical laboratory science, nursing, and physical therapy student is required to wear an official school uniform, which may be purchased at the south campus bookstore, during their clinical placement. Details concerning specific uniform requirements may be secured from the appropriate department chairperson. All students must provide their own transportation to clinical placements. Car pools are often arranged among students. Individuals who do not own automobiles usually can arrange to participate in such a pool.

Massachusetts law requires that all students in the College of Health Professions present certification of immunization against measles, mumps, rubella, tetanus, and diptheria. For a list of additional certification requirements imposed by the University on all students, refer to "Health Certification Requirements" in the Admissions section of this catalog.

INTERDISCIPLINARY OFFERINGS

Minor Program in Health

A minor in health consists of 20-23 credits, at least 6 credits of which must be taken at the 300 course level or above. The minor is open to all students except those matriculated in the College of Health Professions. Course work for the minor is selected by the student in consultation with his advisor and the chairperson of the health department.

Required Courses:	
30-101 Introduction to the Health Professions	(2)
30-103 Life and Health,	
or	
31-301 Contemporary Health Problems	(3)
30-201 Community Health	(3)
30-303 Fitness and Nutrition	(3)
Additional courses are selected from the following list:	
30-201 Human Nutrition	(3)
30-306 Introduction to Gerontology	(3)
30-401 Research and Health Care	(3)
30-550 Bio-Medical Aspects of Aging	(3)
35-101 Principles of Anatomy Physiology I	(3)
35-102 Principles of Anatomy Physiology II	(3)
(Students electing Anatomy & Physiology must complete both 35-101 and 35-102)	
82-351 Human Sexuality	(3)

Students must have approval of the department chairperson and declare the minor by the first semester of the junior year.

Interdiciplinary Courses (Course Prefix: 30)

The following courses are offered by faculty of the several departments of the College of Health Professions and are available for election by students who are enrolled in other colleges.

30-101 INTRODUCTION TO HEALTH PROFESSIONSI,II(2,0)2
Introduces the student to the philosophy of health and human services in the United States, to the philosophy of the College of Health Professions and of the Department of Health. Students will participate in various learning experiences that relate to their personal career choices and the various roles of health professions in the health field. Health faculty (open to the University)

30-201 COMMUNITY HEALTH I,II(3,0)3
Emphasizes the concepts, philosophy and principles of public health and the relationship to the physical, mental and social well-being of the community, its individuals, families and groups. The focus is on the prevention of disease, the promotion and maintenance of health and the provision of environmental and personal health services through organized community effort. Open to all students. College faculty.

30-206 HUMAN NUTRITION I,II(3,0)3
Provides an overview of nutrition and the components of a "nutritious diet" during the various stages of the life cycle. It emphasizes the impact of nutrition on the major contemporary health problems in the United States. Nutrition issues, trends and research and their effect on society and the legislative process will be explored. Open to all students. Prerequisites: 35-101,102. Nicolosi, Hegsted.

30-301 RESEARCH AND HEALTH CARE
This course focuses on the research process, examples of knowledge derived from research, and the application of this knowledge to health care. Various disciplines' research interests, as they relate to health care, are examined for similarities and differences. Open to all students. Coppens.

30-303 FITNESS AND NUTRITION I,II(3,0)3
Designed to show the relationship of nutrition to physical activity. An overview of basic activity, exercise and fitness is provided. Open to all students. Dorsey.

30-306 INTRODUCTION TO GERONTOLOGY I or II(3,0)3
This course will examine human aging from a multi-disciplinary and developmental perspective. The course will focus on the adult years of the life span. The social-psychological factors involved in adjustments to the aging process, to retirement, to family, to leisure, to aloneness, to death and bereavement will be discussed together with such special concerns of the elderly as widowhood, finances, religion, sexuality and health problems. Rehabilitative strategies such as remotivation and reality orientation are included. Open to all students. Futrell.

DEPARTMENT OF CLINICAL LABORATORY SCIENCES

Alease S. Bruce, Chairperson

Professors: Joseph P. Farina, Jacob W. Lam, Robert Nicolosi

Associate Professors: Alease Bruce, Kathleen Doyle, Sandra Fessia, Michael Frechette, Theodore Namm, Edward Weiner

Assistant Professors: Eugene Rogers

The Department of Clinical Laboratory Sciences offers a major with three options: Medical Technology, Clinical Sciences and Exercise Physiology. The major leads to a Bachelor of Science degree. Students select one of the three options.

Accreditation

The Department of Clinical Laboratory Sciences is accredited by the Committee on Allied Health Education and Accreditation (CAHEA) of the American Medical Association.

Clinical Laboratory Sciences

Options of the Clinical Laboratory Sciences program include the following: Clinical Science, Exercise Pysiology, and Medical Technology.

Retention, Continuance, and Appeals Procedure

To qualify for continued matriculation in the options, all students must meet the academic criteria as specified in the retention and continuance policies for the College of Health Professions. Any student who has been denied continuance in either the medical technology option, the clinical sciences option, or the exercise physiology option, for academic reasons or any student who has been dropped from either option for non-academic reasons, may appeal for reinstatement. The appeals procedure for reinstatement is outlined in the policies of the College of Health Professions.

Clinical Sciences

Graduates of the clinical sciences option, by integrating their clinical and non-clinical experiences, are prepared for graduate school and/or for industrial or government employment as research assistants, technical sales representatives, product development personnel, instrument designers, and/or technical service representatives. These students pursue a core of courses similar to students electing the medical technology option, but substitute, in lieu of clinical rotations, additional didactic, laboratory and/or experimental opportunities. While this option is not structured to prepare graduates for certification as medical technologists, it does provide them with an opportunity to specialize in any of the subject areas of clinical science.

COURSE OF STUDY FOR CLINICAL LABORATORY SCIENCES : CLINICAL SCIENCES OPTION (Bachelor of Science)

Freshman Year

	Fall Semester			Spring Semester	
35-101	Anatomy & Physiology*	3	30-201	Community Health	3
35-103	Anatomy & Physiol. Lab*	1	35-102	Anatomy & Phys. II*	3
39-	Physical Education	1	35-104	Anat. & Phys. II Lab*	1
42-101	College Writing	3	39-102	Physical Education	1
47-101	General Psychology	3	42-102	College Writing & Lit.	3
48-101	Intro. to Sociology	3		Elective (Area II)	3
92-101	Pre-Calculus Math	3	92-383	Intro. to Statistics	3
		17			17

* Or equivalent course (must have departmental approval).

Sophomore Year

Fall Semester	
35-211 Basic Clinical Micro. & Pathology	3
35-213 Basic Clinical Micro. & Pathology Lab	1
35-251 Phys. Chem I*	3
35-253 Phys. Chem. I Lab*	1
Elective (Area II)	3
95-103 General Physics I	3
96-103 General Experimental Physics I	1
Elective (Area I or II)	3
	18

Spring Semester	
35-252 Physical Chem. II*	3
35-254 Phys. Chem. II Lab*	1
36-341 Org. React. & Str.*	3
36-343 Org. React. & Str. Lab	1
92-209 Intro. to Computers	
or	
92-261 Intro. to Frotran	
or	
92-263 Fortran Programming	3
General Physics II	3
96-104 General Experimental Physics II	1
	15

Junior Year

Fall Semester	
35-335 Med. & Clin. Genetics*	3
36-321 Cl. Hematology	3
36-323 Cl. Hematology Lab or	
36-493 Directed Studies	1-3
36-350 Human Biochemistry*	3
36-361 Med. Instrumentation	3
36-363 Med. Inst. Lab or	2
36-493 Directed Studies	1-3
	16-18

Spring Semester	
36-311 Med. Microbiology	3
36-313 Med. Micro. Lab or	
36-493 Directed Studies	1-3
36-331 Cl. Immunology	3
36-351 Cl. Biochemistry I	3
36-353 Cl. Biochem. Lab I or	
36-493 Directed Studies	1-3
Clin. Sci. Spec.**	2-5
	14-18

Senior Year

Fall Semester	
36-451 Cl. Biochemistry II	3
36-452 Cl. Biochem. Lab II or	2
36-493 Directed Studies	1-3
36-483 Senior Research	2
Clin. Sci. Spec.**	2-5
Clin. Sci. Spec.**	2-5
	12-18

Spring Semester	
36-484 Senior Research	2
Clin. Sci. Spec.**	2-5
Clin. Sci. Spec.**	2-5
Elective (Area I or II)	3
Elective (Area I or II)	3
	12-18

* Or equivalent course (must have departmental approval).

** Students must select one course from each of the following three "areas of specialization", and a minimum of three additional courses in their chosen area of specialization.

Exercise Physiology

Graduates of the exercise physiology option, by combining liberal arts courses with clinical science and professional courses, are prepared as practitioners in cardiac rehabilitation programs, as teachers, and as researchers. They may also find employment in health spas and sporting centers. Students pursue a core of courses similar to students electing the medical technology and clinical sciences options. On-campus instruction provides students with didactic and laboratory experiences. Supervised clinical training in a health or clinical setting are integrated in the senior year. This option prepares the academically qualified student for admission to the physical therapy program. Open to freshman applicants beginning September 1988.

COURSE OF STUDY FOR CLINICAL LABORATORY SCIENCES : EXERCISE PHYSIOLOGY OPTION
(Bachelor of Science)

Freshman Year

Fall Semester		
35-101	Anatomy & Physiology I	3
35-103	Anatomy & Physio. I Lab	1
39-	Physical Education	1
42-101	College Writing	3
47-101	General Psychology	3
92-101	Pre-Calculus	3
		14

Spring Semester		
30-201	Community Health	3
35-102	Anatomy & Physiology II	3
35-104	Anatomy & Physio. II Lab	1
39-	Physical Education	1
42-102	College Writing	3
	Elective (Area II)	3
48-101	Intro. to Sociology	3
		17

Sophomore Year

Fall Semester		
	Elective	3
35-251	Physiological Chemistry I	3
35-253	Physiolog. Chem. I Lab	1
95-103	General Physics I	3
96-103	General Experimental Physics I	
92-209	Intro. to Computers	3
30-303	Fitness and Nutrition	3
		17

Spring Semester		
	Elective	3
35-252	Physiolog. Chem. II	3
35-254	Physiolog. Chem. II Lab	1
95-104	General Physics II	3
96-104	General Experimental Physics II	1
	Intro. to Athletic Training and Sports Injuries	3
		14

Junior Year

Fall Semester		
47-328	Dynamics of Interpersonal Relationships	3
	Developing Programs for Fitness, Nutrition, and Weight Loss	3
36-350	Biochemistry	3
36-352	Biochemistry Lab	3
	Elective (Area II)	3
92-383	Intro. to Statitistics	3
		16

Spring Semester		
30-306	Intro. to Gerontology	3
36-315	Kinesiology & Lab	4
35-356	Pharmacology	3
	Fitness Prog. for Spec. Populations	3
	Planning and Evaluation of Fitness Programs	3
		16

Senior Year

Fall Semester		
36-405	Exercise Physiology I	4
36-407	Exercise Phys. I Lab	1
36-401	Clinical Anatomy & Lab	4
36-403	Biomechanics	4
36-409	Clinical Practicum	3
		16

Spring Semester		
36-406	Exercise Phys. II	4
36-408	Exercise Phys. II Lab	1
36-412	Clinical Practicum	3
36-414	Research Methods in Exercise Physiology	4
	Marketing and Administration of Exercise Programs	3
		15

Medical Technology

Graduates of the medical technology option are qualified to write either or both of the registry examinations sponsored by the American Society of Clinical Pathologists (M.T.ASCP) and/or the National Certifying Agency for Clinical Laboratory Personnel (CLS-NCA). This option provides the student with the scientific knowledge, technical skills, and hands-on experience required to function in all areas of the clinical laboratory. This integrated curriculum is offered in cooperation with the clinical laboratories in hospitals of the Greater Boston area.

On campus instruction provides students with didactic and simulated clinical laboratory experiences in each of the four major areas of the clinical laboratory: clinical chemistry, clinical hematology, clinical immunohematology, and clinical microbiology. Hospital-based clinical rotations are integrated with the didactic laboratory curriculum during the junior and senior years of the program. Students are advised that it may be necessary to schedule clinical rotation at times other than during the normal academic calendar.

This option also allows for upward mobility of current practitioners in the field including associate degree graduates with MLT(ASCP) certification or CLA(ASCP) certification. The growing complexity and significance of the role of the clinical laboratory in the delivery of health care accentuates the importance to its professionals receiving an education commensurate with the responsibilities of the clinical laboratory scientist. Medical technologists perform tests on various body fluids and tissues to determine the presence or absence of disease, to monitor response to disease, and to aid in health maintainance. They are indispensable laboratory personnel—the supervisors, the instructors and/or the specialists, for a wide range of complex diagnostic and therapeutic procedures.

After completion of this program, the medical technologist will be able to:

1. Collect and process biological specimens for analysis.
2. Perform analytical tests on body fluids, cells and products.
3. Integrate and relate data in making critical judgements.
4. Evaluate the results of quality control and institute corrective procedures.
5. Perform preventive and corrective maintenance of equipment and instruments or refer to appropriate source.
6. Evaluate new techniques and procedures for usefulness and practicality within the context of personnel, equipment, space and budget resources.
7. Demonstrate concern for the patient and cooperate with others in the medical community.
8. Communicate effectively with others.
9. Assume responsiblility for continuing professional development and competence.
10. Assume leadership to effect positive changes in the profession.
11. Apply principles of management, supervision and educational methodology.

COURSE OF STUDY FOR CLINICAL LABORATORY SCIENCES : MEDICAL TECHNOLOGY OPTION (Bachelor of Science)

Freshman Year

Fall Semester		Spring Semester	
35-101 Anatomy & Physiology I	3	30-201 Community Health	3
35-103 Anatomy & Physiology I Lab	1	35-102 Anatomy & Physiology II	3
39- Physical Education	1	35-104 Anatomy & Physiology II Lab	1
42-101 College Writing	3	36-273 Intro. to Medical Tech.	2
47-101 General Psychology	3	39-102 Physical Education	1
48-101 Intro. to Sociology	3	42-102 College Writing & Lit.	3
92-101 Pre-Calculus Math.	3	92-209 Intro. to Computer Prog. or 92-261 Intro. to Fortran or 92-263 Fortran Prog.	3
	17		16

Sophomore Year

Fall Semester

35-211	Basic Clinical Micro. & Pathology	3
35-213	Basic Clinical Micro. & Pathology Lab	1
35-251	Physiological Chemistry I	3
35-253	Physiolog. Chem. I Lab	1
	Elective (Area II)	3
	Elective (Area II)	3
	Elective (Area I or II)	3
		17

Spring Semester

35-252	Physiolog. Chem. II	3
35-254	Physiolog. Chem. II Lab	1
36-241	Clin. Lab Theory & Physics	2
36-243	Clin. Lab Techniques	2
36-341	Organic React. & Struct.	3
36-343	Organic React. & Struct. Lab	1
36-345	Clinical Lab Electronics	1
	Elective (Area I orII)	3
		16

Junior Year

Fall Semester

35-335	Medical & Clin. Genetics	3
36-321	Clinical Hematology	3
36-323	Clinical Hematology Lab	2
36-350	Human Biochemistry	3
36-361	Medical Instrumentation	3
36-363	Medical Instr. Lab	2
		16

Spring Semester

36-311	Medical Microbiology	3
36-313	Medical Microbiology Lab	2
36-331	Clinical Immunology	3
36-351	Clinical Biochemistry I	3
36-353	Clin. Biochem. I Lab	2
36-420	Clin. Hematology Practicum	2
36-373	Med. Tech. Seminar	1
		16

Senior Year

Fall Semester

36-410	Clinical Micro. Practicum	2
36-411	Advanced Med. Microbiology	3
36-413	Advanced Med. Microbiology Lab	1
36-431	Clinical Immunohematology	3
36-433	Clinical Immunohemat. Lab	2
36-452	Clinical Biochemistry II	3
36-454	Clin. Biochem. II Lab	2
36-473	Med. Tech. Seminar	1
		17

Spring Semester

36-415	Clin. Virology & Serology	2
36-430	Clinical Immunohematology Practicum	2
36-450	Clinical Chemistry	2
36-453	Professional Aspects of Medical Technology	3
36-474	Med. Tech. Seminar	1
36-451	Urinalsis Practicum	0
	Elective (Area I or II)	3
		13

Minor Program

Clinical Sciences

The Department of Clinical Laboratory Sciences offers a minor in Clinical Sciences which consists of no less than 18 semester hours; six of which must be completed at the 300 level or above. Typically, a minor in clinical sciences would consist of 12 semester hours from among the following:

35-101,102	Principles of Anatomy and Physiology I & II	6
35-103,104	Principles of Anatomy and Physiology Lab I & II	2
35-201,202	Human Anatomy & Physiology I & II	6
35-203,204	Human Anatomy & Physiology Lab I & II	2
35-211	Basic Clinical Microbiology & Pathology	3
35-213	Basic Clinical Microbiology & Pathology Lab	1
35-251,252	Physiological Chemistry I & II	6
35-253,254	Physiological Chemistry Lab I & II	2

and a minimum of six semester hours from among the following:

36-331 Clinical Immunology	3
35-335 Medical and Clinical Genetics	3
35-356 Pharmacology	3
35-358 Environmental and Occupational Health	3
36-350 Human Biochemistry	3

Clinical Laboratory Sciences (Course Prefix: 35)

35-101 PRINCIPLES OF ANATOMY AND PHYSIOLOGY I **I(3,0)3**
An introduction to the study of human organism relating structure and function. The topics treated are cytology, histology, the skeletal system, the muscular system, body plan, the nervous system and the endocrine system. This course is designed to provide students with a working knowledge of human anatomy and physiology through an understanding of the fundamental principles involved in the structure and function of the body, through interrelationships and through feedback mechanisms. Clinical applications will be presented. Corequisite: 35-103, Bruce, Farina, Namm.

35-102 PRINCIPLES OF ANATOMY AND PHYSIOLOGY II **II(3,0)3**
A continuation of the study of the human organism relating structure and function. The topics treated are the circulatory, respiratory, digestive, excretory, and reproductive systems of man. The course is designed to provide students with a working knowledge of human anatomy and physiology through an understanding of the fundamental principles involved in the structure and function of the body, through interrelationships and through feedback mechanisms. Clinical applications will be presented. Prerequisites: 35-101,103. Corequisite: 35-104. Bruce, Farina, Namm.

35-103 PRINCIPLES OF ANATOMY AND PHYSIOLOGY LABORATORY I **I(0,3)1**
The laboratories are designed to reinforce didactic material by practical exposure to the subject matter. A second major outcome will be an understanding of laboratory methodology using a thoughtful approach to problems, precise procedures and an appreciation of variables. Corequisite: 35-101. Members of the department.

35-104 PRINCIPLES OF ANATOMY AND PHYSIOLOGY LABORATORY II **II(0,3)1**
The laboratories are designed to reinforce didactic material by practical exposure to the subject matter. A second major outcome will be an understanding of laboratory methodology using a thoughtful approach to problems, precise procedures and an appreciation of variables. Prerequisite: 35-101,103. Corequisite: 35-102. Members of the department.

35-201 HUMAN ANATOMY AND PHYSIOLOGY **II(3,0)3**
Human Anatomy and Physiology is a two-semester sequence which covers the basic structure and function of the human body. First semester topics include basic body plan, cell anatomy, cell physiology, histology and the integumentary system, skeletal system, muscular system, nervous system, endocrinology and special sensory system. Prerequisite: 84-112 or equivalent. Corequisite: 35-203. Bruce, Farina, Namm.

35-202 HUMAN ANATOMY AND PHYSIOLOGY II **I(3,0)3**
Human Anatomy and Physiology II is a continuation of the study of the human organism, relating structure and function. Among the topics treated will be the circulatory, respiratory, digestive, excretory, and reproductive systems of man. Homeostasis and fluid and electrolyte balance will be emphasized. Corequisite: 35-204. Bruce, Farina, Namm.

35-203 HUMAN ANATOMY AND PHYSIOLOGY LABORATORY I II(0,3)1
The laboratories are designed to reinforce material covered in lecture with practical exposure to the subject matter. Another outcome will be the understanding of and the practical application of basic laboratory techniques and methodology. Corequisite: 35-201. Members of the department.

35-204 HUMAN ANATOMY AND PHYSIOLOGY LABORATORY II I(3,0)1
This course is designed to provide the student with an understanding of laboratory methodology using a thoughtful approach to problems, precise procedures and an appreciation of variables. Prerequisite: 35-203. Corequisite: 35-202. Members of the department.

35-211 BASIC CLINICAL MICROBIOLOGY AND PATHOLOGY I,II(3,0)3
This course is designed to study the fundamentals of microbiology with major emphasis on structure, function, growth, metabolism and classification of clinically important microorganisms. The human body's response to invading microbes, and an introduction to the ecological aspects of microorganisms in the environment with particular stress on their significance, activities (beneficial and detrimental) and control measures will also be studied. Prerequisites: 35-102,104. Corequisite: 35-213. Lam.

35-213 BASIC CLINICAL MICROBIOLOGY AND PATHOLOGY LABORATORY I,II(0,3)1
Laboratory investigations of basic properties and characteristics of microorganisms are conducted. Students will perform commonly used techniques for collecting, handling and studying clinically important microorganisms. Prerequisites: 35-102,104. Corequisite: 35-211. Members of the department.

35-251 PHYSIOLOGICAL CHEMISTRY I I(3,0)3
This is an introductory course designed for students majoring in the associated health sciences. Basic concepts will be covered including: properties of matter, energy, atomic and molecular structure, chemical bonding, periodic table, chemical formulae, and reactions. Radioisotopes and radioactive decay will be discussed along with therapeutic applications. The properties of water and solutions will be studied including: osmosis, dialysis, chemistry of acids, bases and buffers will be covered with specific reference to blood and intracellular buffers, acid/base balance, compensation mechanisms, and diagnosis of fluid and acid/base disturbances. An introduction to organic chemistry will be provided and will include a discussion of the chemistry of carbon and a survey of the properties and reactions of the major functional groups. Aspects of the chemistry of natural products such as alkaloids, terpenes and vitamins will be studied. Prerequisite: 35-102. Corequisite: 35-253 or 35-255. Frechette, Rogers.

35-252 PHYSIOLOGICAL CHEMISTRY II II(3,0)3
This is a course designed to cover the basic aspects of biochemistry with a strong clinical emphasis. Amino acid and protein structure will be studied. The structure and function of enzymes, the factors which affect their reactions and the diagnostic use of enzyme assays in clinical medicine will be covered. Plasma proteins, hemoglobin, chemistry of nucleic acids, protein catabolism and selected pathological conditions connected with proteins are stressed. The chemistry of carbohydrates and lipids and their major metabolic pathways are studied with clinical applications and correlations with various disease states. Interpretations of selected clinical laboratory tests are included. Hormonal secretion, target specificity, mechanisms of control and specific mechanisms of action of the major hormones which affect protein, carbohydrate and lipid metabolism are studied, along with disease states which alter hormone balance. Recent studies from the current literature are included wherever possible. Prerequisite: 35-251. Corequisite: 35-254 or 35-256. Frechette, Rogers.

35-253 PHYSIOLOGICAL CHEMISTRY I LABORATORY I(0,3)3
Laboratory experiments are conducted to complement the material covered in 35-251. Exercises dealing with properities of matter, chemical equations, qualitative analysis, energy, osmosis, chemical equilibrium and acids/bases/buffers will be performed. The qualitative properties of alcohols, aldehydes, ketones, acids and esters will be explored. Corequisite: 35-251. Members of the department.

35-254 PHYSIOLOGICAL CHEMISTRY II LABORATORY II(0,3)1
Laboratory experiments are conducted to complement the material covered in 35-252. The chemistry of the basic biochemical molecules will be explored, including proteins, enzymes, carbohydrates, lipids, and nucleic acids. Selected aspects of metabolism and the assay of clinically significant materials will be studied. Prerequisite: 35-253 or 35-255. Corequisite: 35-252. Members of the department.

35-255 PHYSIOLOGICAL CHEMISTRY I LABORATORY II(0,3)1
Similar to 35-253. Clinical Science majors only. Corequisite: 35-251. Members of the department.

35-256 PHYSIOLOGICAL CHEMISTRY II LABORATORY II(0,3)1
Similar to 35-254. Clinical Science majors only. Corequisite: 35-252. Members of the department.

35-335 INTRODUCTION TO MEDICAL & CLINICAL GENETICS I(3,0)3
A course designed to exemplify the pathological and clinical aspects of genetics. Background material includes an introduction to cellular and molecular genetics and the metabolic basis of inherited diseases. Immunogenetics, pathological genetics, the influence of chromosome variations on disease conditions, the care and treatment of genetically-based diseases, and the application of genetic precepts to the clinical laboratory will be discussed. The student will learn the psychology, sociology and biology of genetic counseling and learn to apply these principles to everyday situations. The legal implications of genetic decisions will also be discussed in light of recent experimentation being done on the genetic alteration of pharmacological responses, recombination, cloning and other forms of genetic engineering. Prerequisite: 35-102, 35-251,253. Namm.

35-356 PHARMACOLOGY II(3.0)3
An introduction to the chemistry, biochemistry and physiological actions of various pharmaceuticals. Fundamental concepts will be stressed and will include a discussion of drug receptors, drug receptor interactions, pharmacokinetics, enzyme induction, drug metabolism, drug safety and effectiveness and idiosyncratic reactions. Several major groups of drugs will be studied including: central nervous system stimulants, hypnotics, narcotic analgesics, anti-inflammatory drugs, cholinergics, adrenergics, adrenergic blocking drugs, antihypertensives, antihistamines, diuretics, adrenal steroids, anti-anemic drugs and antibiotics. Articles from the current literature will be discussed. Prerequisite: 35-252. Rogers.

Medical Technology and Clinical Sciences (Course Prefix: 36)

36-241 CLINICAL LABORATORY THEORY AND PHYSICS II(2,0)2
This course is designed to introduce the theoretical principles and applications of diagnostic techniques and the procedures of the Clinical Laboratory. It will specifically review each specialty area, defining and describing both qualitative and quantitative, manual and automated laboratory techniques. Corequisite: 36-243. Weiner.

36-243 CLINICAL LABORATORY TECHNIQUES LABORATORY II(0,4)2
A laboratory course designed to expose prospective medical technologists to many of the essestial skills, methods, and procedures basic to professional performance in the clinical laboratory; to explain and demonstrate to students and have them perform these methods; to develop an understanding of these techniques and to provide a technical background; an approach to testing that the student can build upon and use in future courses. Prerequisite: 35-252,256. Corequisite: 36-241. Weiner, Members of the department.

36-273 INTRODUCTION TO MEDICAL TECHNOLOGY II(0,2)2
A course designed to introduce students to aspects of the medical technology profession. Topics include the basic clinical laboratory, discussions, demonstrations, field trips, guest lecturers and selected readings. Doyle.

36-311 MEDICAL (CLINICAL) MICROBIOLOGY I II(3,0)3
A study of the cultural, biochemical, serological and pathogenic characteristics of disease producing microorganisms. Emphasis will be placed on the pathophysiology of the infectious diseases and their relationship to isolation and identification of the pathogenic microorganisms. Prerequisites: 35-211,213. Corequisite: 36-313. Fessia.

36-313 MEDICAL (CLINICAL) MICROBIOLOGY LABORATORY I II(0,6)2
This course is designed to introduce the student to pathogenic microorganisms, media and techniques used in the identification of these organisms. Emphasis will be based upon the isolation, identification and differentiation of pathogenic microorganisms common to man. In addition, quality control and antimicrobial susceptibility testing will be covered. Corequisite: 36-311. Fessia, Members of the department.

36-321 CLINICAL HEMATOLOGY I(3,0)3
A study of the human hematopoietic system and its relationship to other organ systems. Discussions will include morphological and biochemical relationships of erythropoiesis and leukopoiesis in health and disease states. A study of the mechanics of blood coagulation as it relates to health and disease states will also be included. Prerequisites: 35-102,104, 35-252/256. Corequisite: 36-323. Weiner.

36-323 CLINICAL HEMATOLOGY LABORATORY I(0,6)2
This course is designed to emphasize current hematological and coagulation procedures used in today's clinical laboratory. The implications of these tests to diagnose, monitor and evaluate the various hematological disorders will be discussed. Corequisite: 36-321. Weiner, Members of the department.

36-331 CLINICAL IMMUNOLOGY II(3,0)3
An introduction to the principles of Immunology including: the study of antigens and an-

tibodies and their interactions and controls, discription of cellular events and the immune response, and in vivo and in vitro antigen-antibody interactions with clinical relevance. Prerequisite: 35-211,213. Corequisite: 36-333. Bruce.

36-333 CLINICAL IMMUNOLOGY LABORATORY II(0,4)1
A study of the antibody-antigen reactions and the use of current techniques employed for their assay. Methodologies and applied techniques for the blood bank, demonstration via such techniques as precipitation, agglutination, complement fixations will be studied. Corequisite: 36-331. Members of the department.

36-341 ORGANIC REACTIONS AND STRUCTURE II(3,0)3
This course will survey the principles of organic chemistry important for further study in the fields of clinical chemistry and human biochemistry. The chemistry of carbon compounds, bonding and the concepts of isomerism will be studied. Detailed information will be presented on each of the important classes of phenols, ethers, aldehydes, ketones, carboxylic acids and their derivatives, amines and organosulfur and organophosphorous compounds. Emphasis will be placed on chemical structure, physical and chemical properties, nomenclature and general reaction mechanisms. Qualitative analysis of organic compounds will be discussed. The use of spectral techniques, including infra-red, nuclear magnetic resonance and mass spectroscopy for the elucidation of chemical structure will be covered. Frechette.

36-343 ORGANIC REACTIONS AND STRUCTURE LABORATORY II(0,4)1
Laboratory exercises will be performed to complement the material covered in 36-341. Frechette, Members of the department.

36-345 CLINICAL LABORATORY ELECTRONICS II(1,0)1
This course is designed to introduce the basic principles of DC and AC electricity, including the concepts of voltage, current, resistance, induction, capacitance, Ohm's and Kirchoff's Law. RC and RL transient analysis and solid state devices will also be discussed. Frechette, Farina.

36-350 HUMAN BIOCHEMISTRY
This course is an in-depth study of biochemical substances and their reactions in the body, with major emphasis placed on metabolism at the cellular level, and examined in the tissues of the various organs where these reactions occur. Correlation of biochemical processes underlying pathologic conditions will be made whenever practical. Prerequisite: 35-252,256, 36-341,343, or permission of instructor. Corequisite: 36-352. Weiner.

36-351 CLINICAL BIOCHEMISTRY I II(3,0)3
This course deals with the methodology resting for and the interpretation of results for each of the following classes of compounds: carbohydrates, enzymes, proteins, non-protein nitrogen compounds, porphyrins and lipids. Prerequisites: 36-341,343, 36-350,363. Corequisite: 36-353. Rogers.

36-352 HUMAN BIOCHEMISTRY LABORATORY I(0,3)1
This course provides an introduction to the laboratory procedures in the study of carbohydrate protein, nitrogen compounds, porphyrins and lipids. Prerequisite: 35-252,256, or permission of instructor. Corequisite: 36-350. Members of the department.

36-353 CLINICAL BIOCHEMISTRY LABORATORY I II(0,6)2
This course is designed to introduce clinical laboratory procedures by studying the following compounds: carbohydrates, proteins, non-protein nitrogen compounds, porphyrins

and lipids. Methods for troubleshooting, calibration and quality control will be emphasized. Prerequisites: 36-341,343. Corequisite: 36-351. Members of the department.

36-361 MEDICAL INSTRUMENTATION I(3,0)3
This course is designed to provide an in depth knowledge of clinical chemistry laboratory instrumentation. Both theoretical concepts and practical applications will be stressed. Emphasis will be placed on the theory, operation, calibration, troubleshooting and applications of modern day instrumentation in the clinical laboratory. The following techniques will be studied: UV-VIS and IR spectroscopy, fluorometry, nephelometry, turbidimetry, flame emission, atomic absorption, electrodes and potentiometric techniques. ISE analyzers, blood gas instrumentation, coulombetry, enzyme analyzers, adsorption, partition and size exclusion chromatography, gas and high pressure liquid chromatography and radiochemical instrumentation. The design, operation and applications of automated continuous flow, discrete analysis and centrifugal analyzers will be included. Members of the department.

36-363 MEDICAL INSTRUMENTATION LABORATORY I(0,4)2
Laboratory exercises will be performed to complement the material covered in 36-361. Members of the department.

36-373 MEDICAL TECHNOLOGY SEMINAR II(1,0)1
It is essential that students in the medical technology field become and remain aware of current issues related to their profession. This course is designed to inform the student of new technological advances in the medical technology field. Bruce.

36-410 CLINICAL MICROBIOLOGY PRACTICUM I(0,6)2
Supervised clinical training in an affiliated hospital clinical laboratory, designed to reinforce knowledge and skills gained in lecture and laboratory and at the same time introduce the student to the daily activities of the clinical microbiology laboratory. Emphasis will be placed on quality control, methodology and clinical interpertation. Prerequisites: 36-311,313. Members of the department.

36-411 ADVANCED MEDICAL MICROBIOLOGY I(3,0)3
Intensive study of classification, morphology, physiology, genetics and ecology of medically important fungi, parasites and viruses. Emphasis on epidemiology, pathogenicity and host defense. Prerequisites: 36-311,313. Corequisite: 36-413. Fessia.

36-413 ADVANCED MEDICAL MICROBIOLOGY LABORATORY I(0,4)1
The laboratory is designed to emphasize principles and procedures used in the isolation, cultivation, and identification of medically important fungi and parasites. Corequisite: 36-411. Fessia, Members of the department.

36-415 CLINICAL VIROLOGY AND SEROLOGY I(2,1)2
This course is designed for the student of laboratory medicine who wishes to better understand and utilize the analytical capabilities of immunological tests. The course emphasizes the basic concepts of protein chemistry and immunology that are necessary for the understanding of clinical applications. Currently employed immunodiagnostic techniques will be reviewed, describing principle, methodology, inferences, clinical correlations, and interpretations. Prerequisite: 36-331. Fessia.

36-420 CLINICAL HEMATOLOGY PRACTICUM II(0,6)2
Supervised clinical training in an affiliated hospital laboratory. Designed to reinforce knowledge and skills gained in lecture laboratory and at the same time introduce the student to the daily activities of a clinical hematology laboratory. Emphasis will be placed on quality control, methodology, and clinical interpretation. Prerequisites: 36-321,323. Members of the department.

36-430 CLINICAL IMMUNOHEMATOLOGY PRACTICUM **II(0,6)2**
Supervised clinical training in an affiliated hospital clinical laboratory, designed to reinforce knowledge and skills gained in lecture and laboratory and at the same time introduce the student to the daily activities of the clinical immunohematology laboratory. Emphasis will be placed on quality control, methodology and clinical interpretation. Prerequisites: 36-331,332,431,433. Members of the department.

36-431 CLINICAL IMMUNOHEMATOLOGY **I(3,0)3**
Lecture and case study discussions look at the major red cell antigen systems which are of importance in understanding transfusion therapies and compatibility testing. Emphasis is on differentiation and clinical significance of each system. Also discussed are HLA antigens. Prerequisites: 36-331,333. Corequisite: 36-433. Doyle.

36-433 CLINICAL IMMUNOHEMATOLOGY LABORATORY **I(0,4)2**
Practical laboratory experience in blood banking, illustrating the concepts stressed in the lecture. Prerequisite: 36-331,333. Corequisite: 36-431. Doyle, Members of the department.

36-450 CLINICAL BIOCHEMISTRY PRACTICUM **II(0,6)2**
Supervised clinical training in an affiliated hospital clinical laboratory. Designed to reinforce knowledge and skills gained in lecture and laboratory and at the same time introduce the student to the daily activities of the clinical laboratory. Emphasis will be placed on quality control, methodology and clinical interpretation. Prerequisites: 36-452. Members of the department.

36-451 URINALYSIS PRACTICUM **II(0,1)0**
A one week clinical rotation designed to give the student experience in microscopic examination and evaluation of urine sediments. Emphasis is on correlating physical and chemical characteristics with sediment evaluation and diagnoses. Additional routine tests of a physical and chemical nature will be performed and demonstrated. Prerequisites: 36-452,454. Members of the department.

36-452 CLINICAL BIOCHEMISTRY II **I(3,0)3**
Topics include methodologies and clinical correlations in the area of: urinalysis, acid base balance, electrolytes, hormones, toxicology, vitamins, gastric analysis, amniotic fluid and biochemical profiles. Prerequisites: 36-354,351,353. Corequisite: 36-454. Rogers.

36-453 PROFESSIONAL ASPECTS OF MEDICAL TECHNOLOGY **II(3,0)3**
This course will acquaint the student with the many managerial, educational, technical, and administrative theories and practices, as well as moral and ethical issues that may confront the health care professional functioning within a clinical or research laboratory setting. In addition, it will present the varied career opportunities that are available for graduates. Weiner.

36-454 CLINICAL BIOCHEMISTRY LABORATORY II **I(0,6)2**
This course is designed to instruct the student in the analytical procedures and methods currently used in the clinical laboratory, and is a continuation of 36-353. Manual and automated methods utilized in the assessment of such topics as acid-base balance, hormones, toxicology and vitamins will be introduced. In addition, methods associated with the routine examinations of urine will be introduced. Quality control, laboratory safety and professional performance are emphasized. Prerequisite: 36-353. Corequisite: 36-452. Members of the department.

36-483 SENIOR RESEARCH **I(0,6)2**
Students along with their faculty advisor will structure a research project commensurate with the student's area of specialization. A paper embodying the results of the research

project will be presented to the senior research project committee. Members of the department.

36-484 SENIOR RESEARCH **II(0,6)2**
Continuation of 36-483. Members of the department.

36-493 DIRECTED STUDIES **I,II(0,6)3**
Students along with their faculty advisor will structure an acceptable project in one of four areas: research, program development, teaching, or clinical practicum. Students are eligible to receive from 1 to 3 credits in accordance with departmental policy. Members of the department.

Exercise Physiology (Course Prefix: 36)

36-315 KINESIOLOGY AND LAB **II(3,3)4**
This course deals with the mechanics of human motion with emphasis on body mechanics and those deviations from sound mechanical principles which effect it. The laboratory portion of the course introduces the student to the techniques used to analyze human motion. Members of the department.

36-405 EXERCISE PHYSIOLOGY I **I(4,0)4**
The study of the effects of exercise regimes on human physiology utilizing modern techniques of research. Students taking this course are advised that the capability to exercise moderately will be necessary. Prerequisite: 36-315. Corequisite: 36-407. Members of the department.

36-407 EXERCISE PHYSIOLOGY I LAB **I(0,3)1**
This course will permit students the opportunity to put into practice theories and principles taught in lecture. Prerequisite: 36-315. Corequisite: 36-405. Members of the department.

36-403 BIOMECHANICS **I(4,0)4**
This course focuses on the description and analysis of human motion using a variety of mechanical cinematographic techniques. Research techniques will be utilized. Prerequisite: 36-315. Members of the department.

36-409 CLINICAL PRACTICUM I **I(0,6)3**
Supervised clinical training in a health or clinical setting, designed to reinforce knowledge and skills gained in the junior and senior years and to provide students with an opportunity to practice administrative and organized skills. Students will be supervised in the attainment of identified objectives. Senior exercise physiology majors only. Members of the department.

36-412 CLINICAL PRACTICUM II **II(0,6)3**
Clinical training in a health or clinical setting. Students will be supervised in the attainment of identified objectives. Senior exercise physiology majors only. Members of the department.

36-406 EXERCISE PHYSIOLOGY II **II(4,0)4**
This course focuses on abnormalities of the cardio-respiratory and circulatory systems. Students will through evaluation and analysis of these abnormalities, be taught how exercise effects them. Prerequisites: 36-405,407. Corequisite: 36-408. Members of the department.

36-408 EXERCISE PHYSIOLOGY II LAB **II(0,3)1**
This course will permit students the opportunity to put into practice theories and prin-

ciples taught in lecture. Prerequisite: 36-405,407. Corequisite: 36-406. Members of the department.

36-417 RESEARCH METHODS IN EXERCISE PHYSIOLOGY II(0,4)4
This course deals with research methods currently employed in exercise physiology. It will also examine the effects of exercise on the human body. Students will be required to complete and present individual or group research projects in areas of interest in exercise physiology. Seniors only. Members of the department.

DEPARTMENT OF HEALTH

Karen M. Lorentzen, Chairperson

Professors: Karen M. Lorentzen, Robert Neal, Beverly Volicer

Assistant Professor: Linda Roemer

The faculty of the Department of Health believes that each individual is a unique, rational human being who must have the opportunity to interact effectively within a changing environment. Individuals possess innate rights, one of which is the attainment of the goal of optimal health. Society, through its community and educational institutions, has a responsibility to make available for its citizens the methods and means for achieving the goals for optimal levels of health. To this end, the department of health is committed to prepare professional practitioners who, from their own health practice discipline, assist the individual, the family, the group, and the community to achieve as high a level of health as possible.

The Department of Health offers majors in health education, leading to the degree of Bachelor of Science, and health services administration, leading to a Master of Science. For information concerning the masters program see the Graduate School Catalogue.

The health education program is fully accredited by the Massachusetts Department of Education, Bureau of Teacher Certification and the National College Association for Teacher Education.

Health Education Major

The health education major is a dual program which encompasses both community and secondary school health education and prepares graduates to establish and teach health programs in the public schools and community agencies such as public health departments, hospitals, industry, college health services and health maintenance organizations.

Health education has emerged as an educational discipline to effectively meet society's ever-increasing need for accurate health knowledge. Health education builds its body of knowledge on the arts and sciences and deals with the theory of health science. The application of this theory to practice requires the development of necessary effective teaching skills. These skills include the knowledge of developing curriculum based on health theory. This application also requires the acquisition of a variety of teaching and evaluation skills that are integral to effective health education. In addition, health-based curriculum and teaching plans for changing negative health attitudes and behavior are developed to reinforce existing positive health attitudes and behavior. Health educators must be able to communicate effectively, particularly in the areas of public speaking and be able to maintain good relations with people of all ages. The goal of the health education program is to prepare entry level professional practitioners who have a foundation for continuing professional development and individual growth in addition to the ability to function effectively in a variety of settings.

At the completion of the health education program, the graduating student will be expected to:

1. Teach effectively and demonstrate mastery in the major areas of health education curriculum.
2. Incorporate in the teaching process and interactions with people the broad-based areas of knowledge existing in the liberal arts and biological sciences.
3. Recognize and acknowledge the multi-cultural diversity of populations and incorporate this understanding into educational and professional practices.
4. Assess needs effectively and develop, present, and evaluate health education programs.
5. Demonstrate knowledge about research, current trends and issues in the areas of general education and health education for continued professional and personal growth.
6. Be an active participant in developing national awareness for disease prevention and increasing the quality of life for all citizens, individually and collectively, through health education.
7. Appreciate the applicability of computer technology to instruction and evaluation in health education.

Major courses in health education are offered within the Department of Health. The field practicums are developed, coordinated, and supervised by department faculty in conjunction with preceptors of the community agencies and secondary schools which are utilized. Field experiences are integrated from the freshman year throughout the upper division health education courses.

Retention, Continuance, and Appeals Procedure

To qualify for continued matriculation in the health education program, all students must meet the academic criteria as specified in the retention and continuance policies for the College of Health Professions.

Any student who has been denied continuance in the health education major for academic reasons, or any student who has been dropped from the program for non-academic reasons, may appeal for reinstatement as outlined in the policies of the College of Health Professions.

Application for Professional Certification

Upon completion of the baccalaureate degree program in health education at the College of Health Professions, senior students may file for professional certification to teach in Massachusetts. When the application materials are complete, the college will recommend the student for a teaching certificate and the appropriate endorsement will be entered on his/her permanent record card. The Massachusetts Department of Education, Bureau of Teacher Certification, has the sole legal responsibility for granting certification.

COURSE OF STUDY FOR HEALTH EDUCATION (Bachelor of Science)

Freshman Year

Fall Semester		
30-201	Community Health	3
35-101	Anatomy & Physiology I	3
35-103	Anatomy & Physiology Lab I	1
39-	Physical Education	1
42-101	College Writing I	3
47-	Psychology Elective (Area I)	3
48-	Sociology Elective (Area I)	3
		17

Spring Semester		
30-101	Introduction to Health Professions	2
35-102	Anatomy & Physiology II	3
35-104	Anatomy & Physiology Lab II	1
	Elective (Area II)	3
39-	Physical Education	1
42-102	College Writing II	3
47-163	Human Life Span	3
		16

Sophomore Year

Fall Semester		
31-201	Contemporary Health Problems	3
35-251	Physiological Chemistry I	3
35-253	Physiological Chemistry Lab I	1
	Elective (Open)	3
82-351	Human Sexuality	3
92-383	Introduction to Statistics	3
		16

Spring Semester		
30-206	Human Nutrition	3
31-202	Introduction to Health Education	3
35-211	Basic Clinical Microbiology & Pathology	3
35-213	Basic Clinical Microbiology & Pathology Lab	1
35-252	Physiological Chemistry II	3
35-254	Physiological Chemistry Lab II	1
	Elective (Human Values)	3
		17

Junior Year

Fall Semester		
01-371	Educational Psychology	3
01-391	Philosophy of Education	
	or	
01-392	Philosophy of Moral Issues in Education	3
31-302	Environment & Consumer Health	3
31-306	Curriculum & Methods of Teaching Health Ed. I	3
47-328	Dynamics of Interpersonal Relationships	3
	Elective (Area II)	3
		18

Spring Semester		
01-384	Educational & Cultural Diversity	3
30-306	Introduction to Gerontology	3
31-304	Drug, Alcohol & Smoking Education	3
31-307	Curriculum & Methods of Teaching Health Ed. II	3
	Elective (Open)	3
		15

Senior Year

Fall Semester		
31-402	Safety Education	3
31-403	Community Health Education Practicum & Seminar*	9
31-404	Mental Health Education & Health Counseling	3
		15

Spring Semester		
31-405	Apprentice Teaching of Health Secondary Schools & Seminar*	12
		12

* If the student has a special request for a field placement in the community or student teaching practicum, the request must be in by:

April 15 for the community practicum
November 15 for the student teaching practicum.

No student will be allowed to participate in an internship until all prerequisite courses have been completed. The ultimate decision regarding field assignments rests solely with the faculty of the department.

Health Education (Course Prefix: 31)

31-201 CONTEMPORARY HEALTH PROBLEMS I(3,0)3
This course focuses on the major contemporary problems and diseases that afflict people throughout the life cycle. The physical, mental and social etiology of disease is stressed with great emphasis in the area of prevention. Members of the department.

31-202 INTRODUCTION TO HEALTH EDUCATION II(3,0)3
This course introduces students to health education as a profession in its own right and the function or role of other professionals (e.g., teachers, health care providers, social service workers). Determinants of health behavior are discussed and how health education can influence behavior on both the individual and societal levels. Principles of program development and evaluation will be examined and examples of the practice of health education in a wide variety of settings will be presented. A philosophy of health education will be developed to serve as a basis for practice. The course will also focus on communication as an integral aspect of the function of the effective health educator. Members of the department.

31-302 ENVIRONMENTAL AND CONSUMER HEALTH I(3,0)3
Environmental health develops the concept that the existence of man will depend on his ability to interact effectively with the total environment and focuses upon the effect of environment on the individual's health. Consumer health assists in the process of discriminating between reliable and unreliable health information and advertising and assists the consumer in choosing health services wisely. Members of the department.

31-304 DRUG, ALCOHOL, AND SMOKING EDUCATION II(3,0)3
This course focuses on the varied aspects of drug use/misuse: physiological and psychological impact, enforcement problems relative to violation of drug laws, rehabilitation programs in the area of drug addiction and problems, social and economic implications, personal, community and social responsibilities and various educational programs and approaches. Members of the department.

31-306 CURRICULUM AND METHODS OF TEACHING HEALTH EDUCATION I I(3,0)3
This course focuses on the various aspects and dimensions of curriculum development, planning and methodology; the importance and ramifications of needs assessments; and the current trends and issues in the field of health education curriculum development. The development of a viable health curriculum is an important focus of the course. Members of the department.

31-307 CURRICULUM AND METHODS OF TEACHING HEALTH EDUCATION II II(3,0)3
This course focuses on the application of techniques of educational measurement and evaluation to health education in school, community, and occupational settings. Construction and evaluation of measures of knowledge, attitudes, and behavior are discussed in detail. Students are introduced to the use of computers in health education, instruction and evaluation. Prerequisite: 31-306. Members of the department.

31-402 SAFETY EDUCATION
This course focuses on the personal, community, industrial and environmental aspects of safe living behavior and safety education as well as the resources and agencies that are directly concerned with the varied facets of first aid and safety delivery and education. Members of the department.

31-403 COMMUNITY HEALTH EDUCATION PRACTICUM I(APR)9
The course is an eight-week, full time health education field experience for senior students that takes place within the setting of a community agency. the student paricipates in the development, implementation and evaluation of health education programs and takes an active part in the total community health education process. Prerequisite: All freshman, sophomore, and junior courses. Members of the department.

31-404 MENTAL HEALTH EDUCATION AND HEALTH COUNSELING I(3,0)3
This course stresses the idea that one's feelings about the self are the basic determinant of mental health. A positive model of mental health is developed and techniques of dealing with life stresses are discussed with the objective of implementing these concepts in the school health curriculum. Health counseling develops an understanding of the theory and practice of counseling. Members of the department.

31-405 APPRENTICE TEACHING OF HEALTH IN SECONDARY SCHOOLS II(APR)12
This course meets the apprentice teaching requirements for teacher certification set by the State Department of Education. The student spends the entire semester in a local public school. Placement is arranged by University faculty supervisors. Prerequisite: All freshman, sophomore and junior courses. Members of the department.

DEPARTMENT OF PHYSICAL THERAPY

Joseph A. Dorsey, Chairperson

Associate Professors: Barbara Cocanour, Gwenyth Gerhard, Linda Kahn-D'Angelo

Assistant Professor: Susan O'Sullivan

Instructors: Jo Anne Pelletier, Barbara Tynan

Academic Coordinator Clinical Education: Nancy Peatman

Physical Therapy Major

The physical therapist works with medical personnel and community health organizations in contributing to programs of patient care and management, the general aims of which are the prevention and alleviation of bodily disfunctions or deformity. The therapist may serve in hospitals, industry, community health agencies, rehabilitation centers, or may maintain a private practice. Individuals who are interested in scientific and medical fields and who enjoy working closely with people of all ages will find physical therapy a career which is rewarding and fulfilling. The physical therapy program is fully accredited by the American Physical Therapy Association.

The faculty of the Department of Physical Therapy believes that individuals have intrinsic worth and a right to optimal health which enables them to interact effectively in a changing environment. To this end, members of society are responsible for taking an active and cooperative role in personal health maintenance. When physical, biological, psychological or social imbalances occur they may cause a deficit in effective function. Physical therapy is integral to the prevention of disability caused by these imbalances as well as to the maintenance or rehabilitation of individuals to their optimal level.

To meet the physical therapy needs of society, the practitioner must be prepared in an academic program which emphasizes the synthesis of the pure and applied sciences sociology, psychology and human values and integrates didactic knowledge, theory and psychomotor skills. The physical therapy graduate is a competent professional who uses the problem solving approach for teaching, management, consulting, advocacy and research to provide services for the whole person.

Physical therapists are prepared to practice independently and coperatively as members of a health care team in a variety of settings: hospitals, rehabilitation centers, schools, extended care facilities, industry, sports medicine programs, community health agencies, and private practices.

The faculty believes that students are active participants in the educational process. As potential professionals the relationship between students and faculty should be one in which there is mutual respect, understanding and interchange of ideas. Faculty, as experienced professionals are resource persons, counselors, facilitators, motivators and role models for the potential professional. Students are self-directed, committed and motivated to identify and pursue professional goals. As developing professionals these students must demonstrate a commitment to professional values and the adoption of the professional code of ethics.

Curricular Goals

The graduate of the program in Physical Therapy at the University of Lowell will be prepared to:

1. Respect human dignity.
2. Promote the prevention of disability, the rehabilition to and the maintenance of optimal function through practice of physical therapy.
3. Synthesize pure and applied sciences, sociology, psychology and human values with the integration of didactic knowledge theory and psychomotor skills.
4. Utilize a perspective which combines both the physical and the psycho-social aspects of health care.
5. Interact and communicate effectively with others.
6. Evaluate the physical therapy needs of individuals of all ages using the problem solving approach.
7. Design and implement an individualized physical therapy plan of care based on identified needs using the problem-solving approach.
8. Utilize psychomotor skills in the effective treatment of clients.
9. Incorporate the affective dimension in the evaluation and treatments of clients through the use of the empathic process.
10. Evaluate and use professional research and literature in the delivery of physical therapy services.
11. Integrate teaching and learning principles in all facets of physical therapy practice.
12. Participate in change within the health care delivery systems to assure quality health care.
13. Consult effectively with clients and other members of the health care team.
14. Organize and develop a physical therapy service.
15. Practice physical therapy in a variety of health care centers.
16. Practice physical therapy in a safe, effective, ethical and legal manner.
17. Assume responsibility for self-directed study and continuing professional development.
18. Value the generation of new knowledge and the validation of current practice for continuing development of the profession.
19. Value the code of ethics in professional practice.

Clinical Affiliations

Clinical affiliations are integrated from the second semester sophomore year throughout the upper division physical therapy courses. Full time affiliations are scheduled in the summer of the junior year and the spring semester of the senior year. The clinical aspects of the physical therapy program are developed, coordinated, and supervised by the physical therapy faculty and are provided in collaboration with health agencies and hospitals throughout New England and the Northeast. Physical therapy students are responsible for all transportation, housing costs and meals related to affiliations and students should expect to be placed outside of the local university area for one or all affiliations.

Required Uniforms

At the beginning of their affiliations, students are required to purchase uniforms consisting of navy blue trousers, white lab coats, and white or black hospital shoes, name tags and insignia. All of these requirements may be purchased at the South Campus Bookstore.

Retention, Continuance, Grading Policies and Appeals Procedure

The retention, continuance, and grading policies for physical therapy majors will follow those policies as specified in the section on retention and continuance policies for the College of Health Professions. In addition, the clinical affiliations are graded on an "S" (satisfactory) or "U" (unsatisfactory) basis. A grade of "S" indicates that a student has satisfactorily completed the course objectives for the clinical experience. A grade of "U" indicates that a student was unable to meet the course objectives and will be immediately dropped from the program. Such students may seek reinstatement to the program through the appeals procedure.

Any student who has been denied continuance in the physical therapy major for academic reasons, or any student who has been dropped from the program for non-academic reasons may appeal for reinstatement. The appeals procedure for reinstatement is outlined in the policies of the College of Health Professions.

Transfer Policies for Physical Therapy

The program in physical therapy does not accept transfers directly into the program because of the numbers of freshman students desiring entrance into the program. Students who wish to transfer must first be accepted to the University as undeclared health majors with no more than thirty transfer credits and then compete academically for positions as they become available in the physical therapy program. Those students who are drawn from the waiting list should be aware that acceptance into the program is dependent upon the space available and successful completion of all prerequisite courses.

COURSE OF STUDY FOR PHYSICAL THERAPY#
(Bachelor of Science)

Freshman Year

Fall Semester

35-101	Anatomy & Physiology I	3
35-105	Anatomy & Physiology I Lab	1
39-	Physical Education	1
42-101	College Writing	3
47-101	General Psychology	3
47-163	Human Life Span	3
	Elective	3
		17

Spring Semester

30-201	Community Health	3
35-102	Anatomy & Physiology II	3
35-106	Anatomy & Physiology II Lab	1
39-	Physical Education	1
42-201	College Writing & Lit.	3
92-383	Intro. to Statistics	3
48-101	Intro. to Sociology	3
		17

Sophomore Year

Fall Semester

35-251	Physiological Chemistry I	3
35-253	Physiological Chem. I Lab	1
42-	Elective (Area II)	3
47-275	Psychology of the Handicapped	3
47-328	Dyn. of Interpersonal Relationships	3
95-103	General Physics I	3
96-103	General Physics I Lab	1
		17

Spring Semester

01-371	Educational Psychology	3
34-200	P.T. Prin. & Practice I	3
34-202	P.T. Prin. & Practice I Lab/Clinic	1
35-252	Physiological Chemistry II	3
35-254	Physiological Chemistry II Lab	1
95-104	General Physics II	3
96-104	General Physics II Lab	1
	Elective	3
		18

Junior Year

Fall Semester

34-301	Advanced Anatomy	3
34-303	Advanced Anatomy Lab	1
34-305	Exercise Physiology	3
34-307	Exercise Physiology Lab	1
34-309	P.T. Prin. & Practice II	3
34-311	P.T. Prin. & Practice II Lab/Clinic	1
34-313	Med. Surg. Conditions I	3
	Elective (Area II)	3
		18

Spring Semester

34-302	Functional Neuroanatomy & Neurophysiology	4
34-304	Functional Neuroanatomy & Neoutphysiology Lab	1
34-310	P.T. Prin. & Practice III	3
34-312	P.T. Prin. & Practice III Lab/Clinic	1
34-314	Med. Surg. Conditions II	3
35-356	Pharmacology	3
34-315	Kinesiology	3
		18

Summer

Session I

34-317	P.T. Prin. & Practice IV	3
34-319	P.T. Prin. & Practice IV Lab/Clinic	1
		4

Session II

34-316	Physical Therapy Clinical Education I	4
		4

Senior Year

Fall Semester

34-401	Management in Physical Therapy	3
34-403	Adv. Therapeutic Tech./Adult	3
34-405	Adv. Therapeutic Tech./Adult Lab/Clinic	1
34-407	P.T. Prin. & Practice V	3
34-409	P.T. Prin. & Practice V Lab	1
34-411	Research in Physical Therapy	3
		14

Spring Semester

34-402	Physical Therapy Clinical Education II	12
		12

Program discontinued September 1991.

Physical Therapy (Course Prefix: 34)

34-200 PHYSICAL THERAPY PRINCIPLES AND PRACTICE I II(3,0)
This course is the first in a series of five courses dealing with the practice of physical therapy. The course introduces the student to the history, the ethics and the terminology used in the profession. The course also introduces the students to the underlying theory of basic physical agents and massage. Architectural barriers as they relate to patient functioning are also introduced. Prerequisites: 35-102,35-104,35-251,35-253,95-103,47-275. Corequisites: 35-252,25-254,95-104,34-202,47-328,96-104. Members of the department.

34-202 PHYSICAL THERAPY PRINCIPLES AND PRACTICE I LAB/CLINIC II(3,0)1
This course is a laboratory course taken concurrently with 34-200. It offers the students an opportunity to practice, demonstrate and test theories in the school laboratory. Students are also taught the techniques of patient transport and ambulation. One laboratory session every month will take place in local physical therapy departments to practice skills. Prerequisites: 35-103,35-104,35-351,35-253,95-102,96-103. Corequisites: 35-252,35-254,95-104,96-104,34-200. Members of the department.

34-301 ADVANCED ANATOMY I(3,0)3
Advanced anatomy is a study of the structures of the human body, utilizing lectures, demonstrations and A.V. materials. Prerequisites: 35-102,35-104,34-200,34-202. Corequisites: 35-252,35-254,95-104,96-104. Members of the department.

34-302 FUNCTIONAL NEUROANATOMY AND NEUROPHYSIOLOGY II(4,0)4
Functional neuroanatomy and neurophysiology presents the structural and functional features of the nervous system as they relate to problems encountered in clinical neurology. Prerequisites: 34-301,34-303. Members of the department.

34-303 ADVANCED ANATOMY LABORATORY I(0,3)1
Advanced anatomy laboratory is the study of the structures of the human body through the laboratory dissection of prosected parts and human cadavers. This course runs concurrently with 34-301. Prerequisites: 35-103,35-104,34-200,34-202. Corequisites: 35-252,35-254,95-104,96-104. Members of the department.

34-304 FUNCTIONAL NEUROANATOMY AND NEUROPHYSIOLOGY LAB II(0,3)1
Functional neuroanatomy and neurophysiology lab is a visualization of the structures of the human brain, spinal cord and peripheral nervous system utilizing dissection and A.V. resources. Prerequisites: 34-301,34-303. Members of the department.

34-305 EXERCISE PHYSIOLOGY I(3,0)3
This course is a study of the effects of exercise on the human organism. The course involves using bicycle ergometry, treadmill running and other exercise regimes in test situations. Students practice the essentials of cardiorespiratory monitoring and respiratory gas analysis in evaluating physiological changes. Exercise is an integral part of the course. Students are therefore, required to present evidence of a current physical exam indicating their health status. Prerequisites: 35-102,35-104,35-252,35-254. Corequisites: 34-200,34-202. Members of the department.

34-307 EXERCISE PHYSIOLOGY LABORATORY I(0,3)1
This course is a laboratory course taken concurrently with 34-305. It offers students the opportunity to test theories and to practice and demonstrate skills developed in 34-305. Prerequisites: 35-101,35-102,35-103,35-104. Corequisites: 35-251,35-252,35-253,35-254, 34-200. Members of the department.

34-309 PHYSICAL THERAPY PRINCIPLES AND PRACTICE II **I(3,0)3**
The topics to be covered in this course include physical therapy evaluation methods and treatment procedures for medical-surgical conditions of the skin, trunk and back, the cardiovascular system, and the respiratory system. The general principles of spinal orthotic fabrication and use are presented and applied to specific physical therapy problems. Prerequisite: 34-202. Corequisite: 34-311. Members of the department.

34-310 PHYSICAL THERAPY PRINICIPLES AND PRACTICE III **II(3,0)3**
This course focuses on evaluation methods and treatment procedures for the upper and lower extremities, head and neck, and evaluation and remediation techniques for gait abnormalities. The general principles or orthotic and prosthetic fabrication and use are presented and applied to specific physical therapy problems. Prerequisites: 34-200,34-309. Corequisite: 34-312. Members of the department.

34-311 PHYSICAL THERAPY PRINCIPLES AND PRACTICE II LAB/CLINIC **II(0,3)1**
Practical application of evaluation techniques and treatment procedures addressed in 34-310 will be emphasized in this course. Topics covered include evaluation and treatment procedures for medical-surgical conditions of the skin, trunk, and back, the cardiovascular system and the respiratory system. One lab session every month will be held in local physical therapy departments to practice the skills learned in the laboratory. Prerequisite: 34-202. Corequisite: 34-309. Members of the department.

34-312 PHYSICAL THERAPY PRINCIPLES AND PRACTICE III LAB/CLINIC **II(0,3)1**
The practical application of evaluation techniques and treatment procedures addressed in 34-310 will be emphasized in this course. Topics covered include evaluation and treatment procedures for the upper and lower extremities and evaluation and remediation techniques for gait abnormalities. The general principles of orthotic and prosthetic use and gait deviations are examined. One lab session each month will be held in local physical therapy departments to practice the skills taught in the laboratory. Prerequisites: 34-200,34-309. Corequisite: 34-310. Members of the department.

34-313 MEDICAL SURGICAL CONDITIONS I **I(3,0)3**
The first part of a two-semester course dealing with medical, surgical, orthopedic and neurological conditions commonly encountered in patients treated by the physical therapist. Emphasis is placed upon the causes of these diseases and the indications for various treatment procedures. Prerequisites: 35-102,35-104,35-252,35-254,34-200,34-220. Corequisites: 34-301,34-303,34-305,34-307,34-309,34-311,34-315. Members of the department.

34-314 MEDICAL SURGICAL CONDITIONS II **II(3,0)3**
This course is a continuation of 34-313 dealing with medical, surgical orthopedic and neurological conditions commonly encountered in patients treated by the physical therapist. Emphasis is placed upon the causes of these diseases and the indications for various treatment procedures. Prerequisites: 35-102,35-104,35-252,35-254,34-200,34-202,34-313. Corequisites: 34-302,34-304,34-310,34-312,35-356. Members of the department.

34-315 KINESIOLOGY **I(3,0)3**
This course deals with the mechanics of human motion with emphasis on body mechanics and those deviations from sound mechanical principles which effect it. The course also introduces the student to the techniques used by physical therapists to analyze human motion. Prerequisites: 35-102,35-104,35-252,35-254,95-103,95-104,96-103,96-104,34-200,34-202. Members of the department.

34-316 PHYSICAL THERAPY CLINICAL EDUCATION I SII(0,40)4
Students enrolled in this course are placed in affiliated hospitals, rehabilitation centers or extended care facilities for a full-time six-week rotation. Learning experiences are provided for the student to apply the theory gained in lecture and further develop their psychomotor skills acquired in the school laboratory. Students are directly supervised by clinical instructors at each facility. This required course for beginning seniors is offered during the second summer session prior to the senior year. Prerequisites: Students must complete all course work up to and including the junior year, must have evidence of liability and medical coverage (available through the University), and must have a health evaluation form completed by a physician. Members of the department.

34-317 PHYSICAL THERAPY PRINCIPLES AND PRACTICE IV SI(3,0)3
This course deals with the theory and application of advanced procedures utilized by physical therapists for evaluation and treatment. Topics covered include: electrodiagnosis, electromyography, therpeutic electrical current, functional electrical stimulation, iontophoresis, transcutaneous electrical nerve stimulation (TENS) and biofeedback. Prerequisites: 34-200,34-202,35-317,34-310,34-312,34-309. Members of the department.

34-319 PHYSICAL THERAPY PRINICIPLES AND PRACTICE IV LAB SI(0,3)1
Practical application of procedures covered in 34-317. Topics covered include electrodiagnosis, therapeutic electrical current, transcutaneous electrical nerve stimulation (TENS) and EMG biofeedback. Members of the department.

34-401 MANAGEMENT IN PHYSICAL THERAPY I(3,0)3
This course is an overview of the operation/functional role of the physical therapy department within the total organizational structure of the health care system. Emphasis will also be placed on the ethical, legal and professional issues pertinent to physical therapists. Students will be given the opportunity to develop basic administrative skills through lectures, reading assignments, class participation and individual and group projects. Members of the department.

34-402 PHYSICAL THERAPY CLINICAL EDUCATION II II(0,40)12
Students apply the cumulative knowledge and skills gained in lecture and laboratory/clinic courses during two full time 8-week rotations at affiliated hospitals, rehabilitation centers, home care agencies, pediatric facilities or private practices. This course is the final clinical component of the students' physical therapy education and occurs during the spring semester of the senior year. Prerequisites: Students must complete all physical therapy courses, must have evidence of liability and medical coverage (available through the University), and must have a health form completed by a physician. Members of the department.

34-403 PHYSICAL THERAPY ADVANCED THERAPEUTIC TECHNIQUES I(3,0)3
This course will explore a variety of treatment methods which are available to the physical therapist for treating adult patients with physical dysfunction. The development of a theoretical model for evaluation and treatment will be based upon concepts of neurophysiology, central nervous system development and dysfunction and of human interaction and learning. Clinical applications will focus on adults with neurological disabilities including CVA, traumatic head injury, spinal cord injury and selected orthopedic problems. Integration of the therapeutic approaches of PNF, NDT, Rood and Brunnstrom will be stressed in order to plan viable and effective treatment programs. Emphasis will be placed upon problem solving using case histories and videotape analysis. Concurrent time in laboratory (PT 34-405) will emphasize the development of specific motor skills necessary for the successful treatment of patients. Prerequisites: 34-200,34-302,34-309,34-310,34-317. Members of the department.

34-405 PHYSICAL THERAPY ADVANCED THERAPEUTIC TECHNIQUES LAB II(0,3)1

Through classroom laboratory experiences, the student will be given the opportunity to gain beginning skills in the practical application of the therapeutic procedures covered in PT 34-403. Prerequisites: Same as 34-403, concurrent enrollment in 34-403. Members of the department.

34-407 PHYSICAL THERAPY PRINCIPLES AND PRACTICE V: THE INFLUENCE OF DEVELOPMENT ON THERAPEUTIC EXERCISE I(3,0)3

This is the last course of a five-part sequence which focuses on the evaluation and treatment of pediatric problems of the CNS and neuromusculoskeletal systems. The development of a theoretical model for evaluation and treatment will be based upon principles of sensorimotor development, neurophysiology, and learning as related to infant/child and caretaker interaction. The course will begin with normal sensorimotor development and will include developmental screening and testing methods. The second and third sections of the course will deal with pathology, evaluation and treatment of pediatric central nervous system dysfunction, and neuromusculoskeletal problems. Emphasis will be placed upon problem solving using case studies. Guest clinician-speakers will share their experiences in pediatric evaluation and treatment and childbirth education. Concurrent time in the laboratory (PT 34-409) will allow the student to observe and practice the skills necessary for evaluation and treatment of pediatric clients. Prerequisites: 34-200,34-302,34-309,34-310,34-317. Members of the department.

34-409 PHYSICAL THERAPY PRINCIPLES AND PRACTICE V: LABORATORY/CLINIC I I(0,3)1

Through classroom and clinical laboratory experiences, the student will be given the opportunity to gain beginning skill in the practical application of material covered in PT 34-407. Members of the department.

DEPARTMENT OF NURSING

May Futrell, Chairperson

Professors: May Futrell, Eleanor Forsley Shalhoup, Janice Stecchi

Associate Professors: Nina Coppens, Elizabeth Daly, Marian Dubrule, Joan Lewis, Eileen Williamson

Assistant Professors: Clarice Andrews, Janet Douglass, Mary Anne Gauthier, Gwenyth Gerhard, Karen Melillo, Patricia Tyra

Instructors: Mary Gardner, Louisa A. Gelser, Susan Murphy, Carole Pearce, Michele Phillips, Cathy St. Pierre, Leah Sak, Jean Ussher

Skills Coordinator: Elizabeth Tavoularis

The Department of Nursing offers undergraduate and graduate degrees in nursing. They are the Bachelor of Science and Master of Science. For information concerning the masters program see the Graduate School Catalogue.

Nursing Major

The nursing program prepares a professional nurse who is a competent, beginning practitioner and has a foundation for graduate study. The goal of the undergraduate program in nursing at the University of Lowell is to prepare professional nurses who have the ability to think logically, to utilize knowledge of relevant theories, and to apply the nursing process with individuals and groups.

Graduates of the nursing program are prepared to function in a variety of settings such as hospitals, visiting nurse associations, and nursing homes. They are eligible to sit for the Board of Registration in Nursing's examination for licensure as a registered nurse.

The nursing program is approved by the Massachusetts Board of Registration in Nursing and is fully accredited by the National League for Nursing.

Philosophy

The philosophy of the Department of Nursing supports the undergraduate and graduate programs within the overall philosophy of the College of Health Professions and the University of Lowell. The faculty of the Department of Nursing accepts the following statements as a reflection of their beliefs.

Man is a unique, sentient, and rational being endowed with individual qualities, but has, in common with other humans, basic needs for respect, worth, and recognition of personal dignity. Man is perceived as continually adapting by developing and interacting, individually or in groups, purposively with a changing multidimensional environment. Dynamic relationships with the environment both enable and limit individual development and health. Man has the right and ability to make choices and establish goals which determine his future. Access to opportunities for growth and possible change is influenced by individual differences and culturally-defined values and beliefs.

Health is a dynamic state of physiological, social, and spiritual well-being and not merely the absence of disease. Man manifests health on a wellness continuum and has the potential for multidimensional movement. Health care is a right and man's option to choose participation in the process of health care delivery must be respected.

Nursing, as an academic and practice oriented discipline, has the responsibility to develop and refine its knowledge base. Through continuing scientific inquiry and analysis of existing theories, new or modified conceptions and relationships can be operationalized in professional nursing practice. Practice is carried out through application of the nursing process and actions that are scientific, rational, deliberate, and humanistic.

The faculty believes that education is a self-actualizing, creative lifetime endeavor which involves values clarification, progressive systematic inquiry, critical analysis, and judgment. Baccalaureate nursing education incorporates liberal education with generalized preparation in professional nursing. The professional nurse is prepared at the baccalaureate level to function in collaborative relationships with other health professionals in a variety of health care settings to deal with diversified health concerns of various clients.

The faculty believes that graduate education in nursing is built upon the development and integration of professional knowledge, attitudes and skills acquired for the first professional degree. Graduate education is based on research and scholarship and includes conceptual formulations of professionalism, systematic inquiry, and leadership. In graduate education, the University's commitment to discover, integrate, interpret, and transmit theories emerging in nursing and other fields, to test models designed to deliver health care and services consonant with the needs of society and the Commonwealth, and to plan to meet future needs of the practice field is emphasized. Students pursuing the masters degree with a major in nursing should be given the opportunity to study the economic, social, political, legal, and technological forces that will affect their roles as leaders. Within these constructs, mastery in one area of specialization in nursing is emphasized. Further professional development and self-actualization occur through continuing education and doctoral study.

The faculty also recognizes that each student is unique and brings to the educational environment a variety of life experiences. Individual interests and goals are recognized as an important component of the educational process. Faculty assumes responsibility for the overall structuring and integration of knowledge and the acquisition of skills to achieve personal and professional goals. Teacher and learner participate in the educational process through planning educationally sound and growth-promoting experiences and sharing knowledge. Support of the individual's growth and self-evaluation during the educational process enables the student to develop his/her own professional philosophy which will be refined throughout his/her career.

Upon sucessful completion of the University of Lowell undergraduate program in nursing, the graduate is prepared as a generalist for beginning professional nursing roles. Specifically, the faculty believes that the graduate is prepared to:

1. Demonstrate, through relationships with others, recognition of intrinsic worth, responsibilities, and rights of self and others.
2. Establish, maintain, and terminate therapeutic relationships with individuals and groups.
3. Utilize the nursing process to make critical judgements when caring for people of all ages in any setting.
4. Integrate relevant principles and theories from the behavioral sciences, natural sciences, and the humanities into the practice of professional nursing.
5. Contribute to the optimal health of individuals, families, and groups by providing safe, competent, professional nursing care independently and in collaboration with others.
6. Integrate teaching/learning concepts into nursing practice to promote health.
7. Assume leadership responsibilities to effect change for the improvement of nursing care.
8. Appreciate the historical perspective of the profession of nursing and the relationship to contemporary and future nursing roles.
9. Contribute to the expanding body of nursing knowledge through application of research findings and/or the participation in research.
10. Accept responsibility for continuous growth as a person, a professional practitioner, and a contributing citizen in society.

Clinical Laboratory Placements

Major courses in nursing are offered within the Department of Nursing and are under the direct control and supervision of the faculty of nursing. The clinical aspects of the nursing program are developed, coordinated, and supervised by the nursing faculty and are provided in collaboration with members of the community agencies utilized. Placements include: Bon Secours Hospital, D'Youville Manor, Lowell General Hospital, Lowell Housing Authority, Lowell Visiting Nurse Association, Nursery Schools, Prescott House Nursing Home, St. John's Hospital, St. Joseph's Hospital, University of Mass. Medical Center, Palm Manor Nursing Home, Veteran's Administration Hospital-Bedford, and Willow Manor Nursing Home. Additional agencies are utilized when necessary to enhance students' learning. Clinical placement of students is at the discretion of the supervising faculty.

Required Uniforms

In order to participate in the clinical portion of the curriculum, each nursing student is required to purchase an official uniform, insignia, appropriate shoes, a name pin, bandage scissors, and a watch with a second hand. Female nursing students also must purchase a cap and either a blue pin-stripe laboratory coat or a navy-blue pants suit for community learning experiences. Male nursing students also must purchase for the community learning experience a blue shirt and blue pants. R.N. students have the option of wearing the University of Lowell student uniform and cap or their own uniform and cap. In any case, the R.N. must wear the University of Lowell student insignia and name pin. Uniform, cap, name pin, and insignia can be purchased at the South Campus Bookstore.

Transfer Policies for Registered Nurses

The Department of Nursing is committed to encouraging registered nurses who possess a diploma or an associate's degree to return to the University for further study leading to a baccalaureate degree with a major in nursing.

Application for admission to the full-time day program of the University is made through the admissions office, University of Lowell. Part-time evening registered nurse students apply through the continuing education office. Registered nurse students entering the department through the Second Chance program must meet the requirements of the Department of Nursing. Faculty are available to advise prospective registered nurse students upon request. Acceptance of credit for transfer courses is determined by the chairperson of the department. Appropriate forms are completed and become a part of the student's record. Evening registered nurse students meet with the program coordinator to determine transfer course credit which is then approved by the chairperson. A photocopy of licensure must be submitted to the department.

Registered nurses are encouraged to utilize the opportunity to gain credit for previous learnings through CLEP or equivalency examinations. Registered nurse students may accelerate through the basic skills and/or physical assessment laboratories of the sophomore year by demonstrating proficiency in these nursing areas. Student activity fees paid by full-time day students cover the cost of CLEP and departmental equivalency exams. Students who are not full-time status (evening program, second chance, and special status students) are required to pay a fee for each examination, as determined by the University. Nursing challenge examinations are administered following the completion of the day program spring semester final examination schedule. To be eligible to take the challenge examinations, one must have successfully completed the following courses or their equivalents as accepted by the department.

College Writing 42-101 and 42-202
Chemistry 84-111,113 and 84-112,114
Anatomy, Physiology 35-201,203 and 35-202,204
Microbiology 35-211,213
Intro. to Statistics 92-383
General Psychology 47-101
Human Life Span 47-101
Psychology of Personality 47-232
Dynamics of Interpersonal Relationships 47-328

Intro. to Sociology 48-101
Intro. to Logic 45-202 or Logic & Language 45-204
Community Health 30-201
Concepts of Professional Nursing Practice 33-201
Pathophysiology 33-202

Preparation and Information

Registered nurse students planning to take the challenge examinations must meet with their advisors to complete the appropriate paperwork prior to the examination period.

An information packet is made available to any enrolled or matriculated Registered Nurse student planning to take the nursing course challenge examinations. This packet contains the course outlines, objectives, topical outlines, and required readings of the courses that are open to challenge. These packets may be purchased by the student.

Challenge courses include:

33-301 Dimensions of Professional Nursing Practice	2 credits
33-302 Concepts Basic for Nursing Intervention	5 credits
33-303 Nursing Care of Clients in Stress I	5 credits
33-304 Nursing Care of Clients in Stress II	6 credits
33-305 Nursing Care of Clients in Stress III	6 credits

Registered nurse students follow the same program of studies as non-nurse students and must meet the same academic criteria. Registered nurse students may request alternative clinical experiences after demonstration of proficiency in a given area. Requests for alternative experiences must be in writing and list objectives to be accomplished. Individual faculty and teaching teams will decide on the educational merit and feasibility of each request.

Retention, Continuance, Grading Policies, and Appeals Procedure

To qualify for continued matriculation in the nursing program, all students must meet the academic criteria as specified in the retention and continuance policies for the College of Health Professions.

In addition, the clinical portions of nursing courses are graded on a "S" (satisfactory) or "U" (unsatisfactory) basis. A grade of "S" indicates that a student has satisfactorily completed the course objectives for the clinical experience. Irrespective of his or her individual achievement in non-clinical course components, a student who receives an unsatisfactory clinical evaluation in a nursing course shall receive a final course grade of "F" (failure) and his or her enrollment shall be terminated immediately.

Any student who has been denied continuance in the nursing major for academic reasons or any student who has been dropped from the program for non-academic reasons may appeal for reinstatement. The appeal procedure for reinstatment is outlined in the policies of the College of Health Professions.

Withdrawal

Students who wish to withdraw from any nursing course are advised that such withdrawal requires simultaneous withdrawal from all nursing courses and termination of enrollment in the nursing program.

Such students who wish to apply for readmission to the nursing program as members of subsequent graduation classes are advised that consideration for readmission is determined not only by academic eligibility requirements in effect for the class to which admission is sought but also by enrollment quotas. Accordingly, students are advised to confer with the Chairperson of the Department of Nursing prior to applying for readmission in order to ascertain if program vacancies exist.

Summary of Degree Requirements

Standard I	
Professional Nursing Courses	58 Credits
Standard II	
College Writing	3 credits
College Writing & Lit.	3 credits
Total	6 credits
Standard III	
Area I	
General Psych.	3 credits
Human Life Span	3 credits
Intro. to Socio.	3 credits
Total	9 credits
Area II	
Logic & Lang. or Intro. to Logic	3 credits
Area II elective	3 credits
Total	9 credits
Area I or II elective	3 credits
Area III	
Exemption due to 5 science courses and statistics required for major.	

Standard IV	
Met within the major	
Physical Ed. Requirement	2 credits
Additional prerequisite & elective courses	44 Total
Total	128

Courses Not Allowed for Credit Towards Degree:

30-101 Intro. to Health Professions
30-103 Life & Health
30-301 Contemporary Health Problems
31-304 Drug, Alcohol & Smoking Ed.
83-123 Nutrition & Disease
83-126 Human Disease & Immunity
83-214 Human Ecology

COURSE OF STUDY FOR NURSING
(Bachelor of Science)

Freshman Year

Fall Semester	
39- Physical Education	1
42-101 College Writing	3
47-101 General Psychology	3
Elective	3
84-111 General Chemistry I	4
84-112 General Chemistry II	4
	14

Spring Semester	
35-201 Anatomy & Physiology I	3
35-203 Anatomy & Physiology Lab I	1
42-102 College Writing & Lit.	3
48-101 Introduction to Sociology	3
47-163 The Human Life Span	3
	17

Sophomore Year

Fall	Semester
35-202 Anatomy & Physiology II	3
35-204 Anatomy & Physiology Lab II	1
35-211 Basic Clinical Microbiology & Pathology	3
35-213 Basic Clinical Microbiology & Pathology Lab	1
45-202 Introduction to Logic	3
47-232 Psychology of Personality	3
Elective (Area I or II)*	3
	17

Spring	Semester
33-201 Concepts for Prof. Nursing Practice	6
33-202 Pathophysiology	3
Elective (Area II)	3
30-201 Community Health	3
92-383 Introduction to Statistics	3
	18

Junior Year

Fall	Semester
47-328 Dynamics of Interpersonal Relationships	3
33-301 Dimensions of Professional Nursing Practice	2
33-302 Concepts Basic to Nursing Intervention	5
33-303 Nursing Care of Patients in Stress I	5
39- Physical Education	1
	16

Spring	Semester
33-304 Nursing Care of Clients in Stress II	6
33-305 Nursing Care of Clients in Stress III	6
Elective (300 level)	3
	15

Senior Year

Fall Semester	
33-401 Nursing Care of Clients in Crisis	12
Elective (300-400 level)	3
	15

Spring Semester	
33-402 Issues & Trends in Nursing	2
33-403 Leadership in Nursing Practice	5
33-404 Comprehensive Nursing Practice	6
Elective	3
	16

* Excluding psychology course.

Nursing (Course Prefix: 33)

33-201 CONCEPTS FOR PROFESSIONAL NURSING PRACTICE II(3,6)6

This course introduces the student to concepts fundamental to the practice of nursing. Consideration is given to the process of adaptation, with emphasis on student adaptation to the professional nursing role. Theoretical aspects and practical application of the nursing process are viewed as the essential method of nursing science and nurse/patient interaction. Health assessment skills are taught and practiced in a laboratory setting. Prerequisite: First 3 semesters of nursing curriculum. Corequisite: 33-202. Members of the Department.

33-202 PATHOPHYSIOLOGY II(3,0)3

This course is designed to present a conceptual approach to human pathophysiology. Content focuses on the basic mechanisms of disease processes and the resulting alterations in body function. Selected major health problems are studied as representative of the concepts of sensory deprivation, autoimmune response, fluid and electrolyte imbalance, oxygen deprivation, abnormal cell proliferation, chemical deregulation, and interference with nutrition and neural dysfunction. Corequisite: 33-201. Members of the Department.

33-301 DIMENSIONS OF PROFESSIONAL NURSING PRACTICE I(2,0)2

This course is designed to increase the student's awareness of nursing as a dynamic evolving profession and to assist in the understanding of the role of a professional nurse. Emphasis is on the refinement of communication and interviewing techniques. Various levels of nursing practice are identified. The nurse as decision maker, teacher, advocate, and researcher is explored. Students are encouraged to analyze their own values as they relate to the values of the professions. Prerequisites: Completion of fourth semester nursing curriculum. Corequisites: 33-302,303. Members of the Department.

33-302 CONCEPTS BASIC TO NURSING INTERVENTION IA(4,12)5
The focus of this course is on the development and utilization of the nursing process in meeting the biopsychosocial needs of individuals at different stages of the life cycle. The role of the professional nurse in health promotion and health maintenance is emphasized. Application of the principles and theories underlying nursing is directed towards care of clients in long term facilities. Prerequisites: 33-201,202. Corequisite: 33-301. Members of the Department.

33-303 NURSING CARE OF CLIENTS IN STRESS I IB(4,12)5
The concepts of stress and adaptation and their relationships to health and level of wellness are considered from a cause and effect perspective. The developmental and situational stressors which influence the health of individuals and their families are explored. Theoretical class content is applied in a variety of clinical practice settings. Prerequisite: 33-302. Corequisite: 33-301. Members of the Department.

33-304 NURSING CARE OF CLIENTS IN STRESS II IIA(6,12)6
This course focuses on assessing man's spectrum of adaptive and maladaptive responses in short-term and long-term setting. Developmental and situational stressors are differentiated. Emphasis is placed on standards of professional practice, while planning and implementing nursing intervention that promote adaptive responses of individuals and families. Prerequisites: 33-301,303. Members of the Department.

33-305 NURSING CARE OF CLIENTS IN STRESS III IIB(6,12)6
The course content focuses on the influence of stress and its effect on communication and health promotion. Clinical learning experiences provide the student with the opportunity to utilize the nursing process in caring for individuals and families experiencing difficulty in coping with stress. Prerequisite: 33-304. Members of the Department.

33-401 NURSING CARE OF CLIENTS IN CRISIS I(5,14)12
Building upon previous knowledge of developmental and situational stressors, crisis is viewed from a theoretical perspective. The dymanics of crisis situations as they involve individuals, families and the community are analyzed. Clinical practice is planned to give students the opportunity to relate their experiences to appropriate theoretical models and to carry out therapeutic interventions appropriate to the care of clients at risk to, or experiencing crisis. Prerequisite: 33-305. Members of the Department.

33-402 ISSUES AND TRENDS IN NURSING II(2,0)2
This course focuses on significant issues and trends resulting from societal developments. The impact of these issues and trends on professional nursing and health care is examined. Prerequisite: 33-401. Corequisite: 33-403,404. Members of the Department.

33-403 LEADERSHIP IN NURSING PRACTICE IIA(4,12)5
The student's potential for directing, guiding and influencing others is developed in selected group experiences. Knowledge gained from theory, research and experience is investigated and analyzed critically. The data are applied to the health care management of clients and families through the use of the nursing process, stressing client advocacy and interdisciplinary cooperation. The student will examine his/her own philosophy, learning needs and growth, preparatory to becoming a more fully self-directed professional nurse. Members of the department.

33-404 COMPREHENSIVE NURSING PRACTICE **IIB(0,24)6**
This clinical course focuses on the transition to the professional nursing role. Planned clinical experiences are provided so that nursing skills can be refined and role behaviors and values internalized. Weekly conferences provide opportunities to share experiences and to evaluate progress in meeting objectives. Prerequisite: 33-403. Corequisite: 33-402. Members of the Department.

DEPARTMENT OF PHYSICAL EDUCATION

Claire Chamberlain, Chairperson

Professor: Richard Aronson

Associate Professors: Claire Chamberlain, Denise Legault, A. James Oliver, James Stone

Assistant Professors: Robert Callary

Instructor: A. Grant Carrow

The Department of Physical Education administers the physical education program which is required of all undergraduate students by the University Core Requirements.

The physical education program of the University has as its general objective the development of basic motor skills which will enhance the productive use of leisure time. More specifically, the program seeks to improve individual health through increased organic vigor, to develop effective sports skills, to attain desirable standards of player conduct, and to promote lifetime interest in physical activity. In attaining these objectives, students are encouraged to select courses from both team and individual activities.

All students, regardless of age, must successfully complete one year of supervised physical activity in fulfillment of the University core requirements. Courses which satisfy the physical education requirement are offered with the prefix number of "39".

Students are permitted to demonstrate proficiency in specified lifetime sports through an equivalency examination. Credits earned (one credit for each examination passed) through these challenge examinations may be used toward satisfaction of the above requirement. For a complete statement on the policy on challenge examinations, including restrictions on eligibility, Cf. the chapter on "Academic Policies: University Core Requirements" in this bulletin.

Interest courses are also offered which deal with current issues and trends in physical education, athletics, and related fields. These courses have the prefix number of "38". These courses do not satisfy the physical education requirement, but may be used as free electives.

Physical Education Interest Courses (Course Prefix: 38)

The following courses may be taken as "unrestricted elective courses" by students who have a general interest in the theory and practice of physical education. These courses do not satisfy the physical education requirement of the University core requirements.

38-100 CARE AND PREVENTION OF ATHLETIC INJURIES **I,II(3,0)3**
The anatomy of all major types of athletic injuries, with emphasis on the nature and extent of injuries and the various modes of prevention and treatment are studied.

38-210 SPORT PSYCHOLOGY **I,II(3,0)3**
Provides students with a basic understanding of the psychological aspects of human behavior in relationship to competitive sports.

38-212 SPORTS IN AMERICA **I,II(3,0)3**
A course designed to acquaint the student with the inherent values of sports as a social phenomenon.

38-321 ORGANIZATION AND ADMINISTRATION OF ATHLETIC PROGRAMS **I(3,0)3**
The organization and administration of individual team and school athletic programs are studied, emphasizing the development of skills in public relations, budgeting, and evaluation.

38-240 THE OLYMPIC GAMES—A CONTEMPORARY VIEW **I(3,0)3**
A course designed to acquaint students with the history, philosophy, economics, and political aspects of the modern Olympic Games.

38-422 LEGAL ASPECTS OF ATHLETICS **II(3,0)3**
A course designed to confront, realistically, the legal issues in athletics, particularly negligence liability and criminal activity as found in the classroom, practice fields, and/or contests for which the coach and/or administrator is held responsible.

Physical Education Activity Courses (Course Prefix: 39)

The following courses, with a course prefix of 39, will satisfy the University's physical education requirement for graduation but may not be credited to academic degree requirements.

39-100 BEGINNING ARCHERY **IA,B;IIA(0,2).5**
To introduce the beginning student to the skills in this highly individualized sport through proper technique and safety procedures. Shooting is done at both 20 and 30 yards in target archery.

39-102 BOWLING **IA,B;IIA,B(0,2).5**
Introduction to ten-pin bowling, the love of the sport, choice of equipment, basic bowling techniques, etiquette, scoring, and types of tournaments with competitive bowling. Extra lane fee for three strings, and shoe rental.

39-105 INTERMEDIATE ARCHERY **IB;IIA,B(0,2).5**
Time is spent to refine the seven basic stages of shooting with introduction to the use of ground markers, pin sights, and the fine points of shooting. Prerequisite: 39-100 or permission of instructor.

39-109 FITNESS FOR WOMEN **IA,B;IIA,B(0,2).5**
To gain an overview of and to experience the various modes of conditioning principles in action through aerobics, XBX, circuit training, music, weight training, and the like. Anatomy and physiology and nutrition and relaxation techniques are discussed to develop a critical approach to fitness.

39-110 FITNESS **IA;IIB(0,2).5**
To improve personal fitness levels through running, progressive flexibility exercises, calisthenics, and weight training.

39-112 BEGINNING GOLF **IA;IIB(0,2).5**
To introduce the beginning student to the basic grip, stance, swing, and etiquette of golf. Use of short, mid-, and long irons with a brief use of the woods.

39-113 INTERMEDIATE GOLF **IIB(0,2).5**
To improve the student's basic golf swing and choice of clubs in stroke strategy. Part of the time will be spent at a driving range and/or at a par-3. Prerequisite: 39-112 or permission of instructor. Extra fee.

39-145 SOFTBALL **IIB(0,2).5**
Basic instruction in the skills involved in playing slow-pitch softball.

39-155 VOLLEYBALL **IA,B;IIA,B(0,2).5**
To learn the techniques and skills used in power volleyball, its rules, etiquette, and team play. Emphasis will be placed on drills and competitive class play.

39-160 BEGINNING SWIMMING **IA,B(0,2).5**
To equip the student with basic water safety skills and knowledge in order to make him/her reasonably safe while in, on, or about the water. To prepare the student for additional water safety skills designed to improve his/her stamina and basic coordination.

39-161 INTERMEDIATE SWIMMING **IB;IIA(0,2).5**
To give the student practice in learning and mastering the basic leg and arm movements essential to good swimming in the front crawl, elementary backstroke, side stroke and breast stroke.

39-162 PRE-LIFESAVING **IIA(2,0).5**
To increase the student's endurance and versatility in the water by providing opportunities to coordinate the parts of a stroke into the whole stroke as well as mastering turns on front, back, and side to employ a wider range of strokes in a closed course. Prerequisite: 39-161 or its equivalent.

39-163 ADVANCED LIFESAVING **IIB(0,4)1**
To provide the student with the knowledge and skills designed to save his own life or the life of another in the event of an emergency. The training is not intended to be a complete lifeguard training course. Prerequisite: 39-162 and current first aid certification.

39-169 WATER SAFETY INSTRUCTOR'S (WSI) **II(0,4)2**
To give the instructor-candidate the knowledge, judgement, teaching skills necessary to train others in swimming skills. To instill a high degree of personal efficiency in swimming and lifesaving skills in order to teach safety in, on, or about the water. Prerequisite: Current first aid certification and 39-163.

39-114 INTERMEDIATE TENNIS **IIB(0,2).5**
Emphasis will be placed on baseline stroking, netplay, serves and effective strategies in singles and doubles. Prerequisite: 39-116 or permission of the instructor.

39-115 INDIVIDUAL SPORTS **IA,B;IIA,B(0,2).5**
To cover rules, strategy, strokes and etiquette of racquetball, handball and squash. In addition, discussion also includes the history of the activities with a comparision of the English and American games.

39-116 BEGINNING TENNIS **IA;IIB(0,2).5**
To acquaint the novice player to forehand, backhand, serve, rules, etiquette, and elementary strategy of tennis. It is hoped that the students will be able to rally successfully at the end of this six-week course.

39-117 ONE-WALL RACQUETBALL **IA,B;IIA,B(0,2).5**
To cover rules, strokes and strategy of this game which was the forerunner of the four-wall game.

39-120 WEIGHT TRAINING **IA,B;IIA,B(0,2).5**
The program is designed for individual instruction in all phases of weight training and is designed to acquaint the student with the benefits of weight training as a method of conditioning.

39-121 NAUTILUS CORPS **I,II(0,4)2**
To acquaint students with proper weight conditioning principles in setting up a strength program as well as the correct use of the Nautilus equipment. By permission of the instructor only.

39-126 BADMINTON **IB;IIA(0,2).5**
To introduce and to refine the basic strokes, footwork, and game strategy of both singles and doubles. In addition, time will be spent on the proper etiquette and the laws of badminton, a fast-paced game.

39-164 ADVANCED SWIMMING **IIB(0,2).5**
For the accomplished swimmer who wishes to enhance swimming and diving skills. Prerequisite: 39-114 or permission of the instructor.

39-170 JUDO **IA,B;IIA,B(0,2).5**
Designed to develop the individual's character, physical abilities, coordination, and balance. Students completing written and practical examinations will be eligible to progress in the various ranks of Judo.

39-180 SWIM AND STAY FIT **IA,B;IIA,B(0,2).5**
A Red Cross program designed to encourage the student to swim regularly until 14 miles are reached. The fitness level of the student will be improved as well as stroke mechanics.

39-227 INDEPENDENT ACTIVITY **IA,B;IIA,B(0,2).5**
For students with severe scheduling problems and who can provide a meaningful proposal for an independent program. This program is granted only after consultation with the instructor. NOTE: Students may be granted (with permission) a maximum of 1.0 credits in the program.

39-228 AEROBIC EXERCISE **IA,B;IIA,B(0,2).5**
A vigorous course for those students wishing to improve their cardio-vascular endurance and efficiency. While moving to music, students are taught proper pulse monitoring and conditioning principles.

39-300 ADVANCED MOTOR SKILLS **IA;IIB(0,4)2**
Students passing this course will demonstrate they are, indeed, physically educated. This course consists of five components: aerobics, aquatics, strength, and both a practical and oral test in a lifetime sport competency.

FACULTY OF THE COLLEGE OF HEALTH PROFESSIONS

OFFICE OF THE DEAN

Eleanor Forsley Shalhoup, R.N., B.S., M.S., C.A.G.S., Ed.D., Dean
Susan Wozenski, A.B., M.P.H., J.D., Assistant Dean

DEPARTMENT CHAIRPERSONS

Alease Bruce, B.S., M.S., Ph.D., Clinical Laboratory Sciences
Claire Chamberlain, B.S.Ed., Ed.M., C.A.G.S., Physical Education

Joseph A. Dorsey, B.S., M.S., C.A.G.S., Ed.D., Physical Therapy
May Futrell, R.N., B.S., A.M., Ph.D., Nursing
Karen M. Lorentzen, R.N., B.S., M.S., Ed.D., Health

RESIDENT FACULTY

Clarice Andrews, Assistant Professor, Nursing; B.S., Simmons; M.S., C.A.G.S., Boston University

Richard M. Aronson, Professor, Physical Education; B.S., Springfield College; M.Ed., Boston University; C.A.S., Springfield College; Ed.D., Boston University.

Alease Bruce, Associate Professor, Clinical Laboratory Sciences; B.S., Hampton Institute; M.S., Ph.D., Howard University.

Robert T. Callary, Assistant Professor, Physical Education; B.S., Springfield College; M.Ed., Fitchburg State College.

Grant A. Carrow, Instructor, Physical Education; A.B., University of New Hampshire.

Claire Chamberlain, Associate Professor, Physical Education; B.S.Ed., Ed.M., Tufts University, C.A.G.S., Northeastern University.

Barbara A. Cocanour, Associate Professor, Physical Therapy; A.B., Defiance College; M.S., Ph.D., University of Maine.

Nina Coppens, Associate Professor, Nursing; B.S., M.S., Northern Illinois University; M.A., Ph.D., University of New Hampshire

Elizabeth Daly, Associate Professor, Nursing; R.N., B.S., M.S., Boston College; D.N.Sc., Boston University.

Joseph A. Dorsey, Professor, Physical Therapy; R.P.T., B.S., Springfield College; M.Ed., Northeastern University; C.A.G.S., New York University; Ed.D., Boston University.

Janet Douglass, Assistant Professor, Nursing; R.N., B.S.N., St. Anselm's College; M.S., Boston College.

Kathleen M. Doyle, Associate Professor, Clinical Laboratory Sciences; (ASCP), B.S., University of Massachusetts; M.S., Ph.D., University of Lowell.

Marian D. Dubrule, Associate Professor, Nursing; R.N., B.S., Iowa State University; M.N., Yale University; M.Ed., M.S., Ed.D., Boston University.

Joseph P. Farina, Professor, Clinical Laboratory Sciences; B.S., M.S., Ph.D., St. John's University.

Sandra L. Fessia, Associate Professor, Clinical Laboratory Sciences; B.A., University of Texas; M.S., Ph.D., Wayne Street Medical School.

Michael Frechette, Associate Professor, Clinical Laboratory Sciences; B.S., Merrimack College; Ph.D., University of Rhode Island.

May Futrell, Professor, Nursing; R.N., B.S., A.M., Columbia University; Ph.D., Brandeis University.

Mary Gardner, Instructor, Nursing; R.N., B.S., State University of New York, Plattsburgh; M.S., Boston University.

Mary Anne Gauthier, Assistant Professor, Nursing; R.N., B.S., Catholic University of America; M.S., Univerisity of Lowell.

Louisa Gelser, Instructor, Nursing; B.S.N., Skidmore College; M.S.N., Boston University.

Gwenyth Gerhard, Associate Professor, Nursing; R.N., B.S., Ohio State University; B.S. (Nursing), University of New Hampshire; M.S., Boston College; Ph.D., University of Arizona.

Linda A. Kahn-D'Angelo, Associate Professor, Physical Therapy; R.P.T., B.A., Merrimack College; M.A., Texas Women's University, Sc.D., Boston University.

Jacob W. Lam, Professor, Clinical Laboratory Sciences; B.S., University of Illinois; M.S., Ph.D., University of Massachusetts.

Denise I. Legault, Associate Professor, Physical Education; B.S., Bridgewater State College; M.Ed., C.A.G.S., Springfield College.

Joan D. Lewis, Associate Professor, Nursing; R.N., B.S., M.Ed., Boston College; Ed.D., Boston University.

Karen M. Lorentzen, Professor, Health (Health Education); R.N., B.S., Adelphi College; M.S., St. John's University; Ed.D., Boston University.

Karen Melillo, Assistant Professor, Nursing; R.N., B.S., Salem State College; M.S., University of Lowell; Ph.D. (cand.), Brandeis University.

Susan Murphy, Instructor, Nursing; R.N., B.S., Worcester State College; M.S. Boston College

Theodore Namm, Associate Professor, Clinical Laboratory Sciences; B.S., M.S., Fordham University; Ph.D., University of New Hampshire.

Robert B. Neal, Professor, Health (Health Education); B.A., University of Massachusetts; M.Ed., Ed.D., Boston University.

Robert J. Nicolosi, Professor, Clinical Laboratory Sciences; B.A., St. Anselm's College; M.S., Ph.D., University of New Hampshire.

James A. Oliver, Associate Professor, Physical Education; B.S., Boston University; M.Ed., Boston State College.

Susan O'Sullivan, Assistant Professor, Physical Therapy; R.P.T., B.S., M.S., Boston University.

Carol Pearce, Instructor, Nursing; R.N., B.S., St. Anselm College; M.S., Boston University

JoAnne Pelletier, Instructor, Physical Therapy; R.P.T., B.S., Univerisity of Connecticut; M.S., Boston University.

Michelle Phillips, Instructor, Nursing; B.S.N., Worcester State College; M.S.N., Boston University.

Linda Roemer, Assistant Professor, Health (Health Administration); A.B., Stanford University; M.A., Ph.D., Tufts University.

Eugene Rogers, Assistant Professor, Clinical Laboratory Sciences; M.T., (ASCP), B.S., Lowell State College; M.S., Northeastern University.

Leah Sak, Instructor, Nursing; R.N., B.S., Salem State College; M.S., Boston University.

Eleanor Forsley Shalhoup, Dean and Professor, Nursing; R.N., B.S., St. Anselm's College; M.S., C.A.G.S.; Ed.D., Boston University.

Cathy St. Pierre, Instructor, Nursing; R.N., B.S., Northeastern University; M.S., University of Pennsylvania.

Janice M. Stecchi, Professor, Nursing; R.N., B.S.N., Boston College; M.Ed., Salem State College; M.S., Ed.D., Boston University.

James E. Stone, Assistant Professor, Physical Education; B.S., Springfield College.

Barbara Tynan, Instuctor, Physical Therapy; R.P.T., B.S., M.S., Boston University.

Patricia Tyra, Assistant Professor, Nursing; R.N., B.S., M.S., Ed.D., Boston University.

Jean Ussher, Instructor, Nursing; R.N., B.A., West Virginia University; B.S., Cornell University; M.S., Boston University.

Beverly J. Volicer, Professor, Health (Health Services Administration); B.A., University of Iowa; M.A., M.P.H., Ph.D., University of Michigan.

Edward Weiner, Associate Professor, Clinical Laboratory Sciences; M.T., (ASCP), B.A., Northeastern University; M.A., Ph.D., Boston University.

Eileen Williamson, Associate Professor, Nursing; R.N., B.S., Lowell State College; M.S., D.N.Sc., Boston University.

Susan Wozenski, Assistant Dean, A.B., Mount Holyoke College; M.P.H., University of Michigan; J.D., University of Connecticut.

ADJUNCT FACULTY

Stephen Havas, A.B., Oberlin College; M.D., University of Pennsylvania; M.S., M.P.H., Harvard University.

D. Mark Hegsted, Clinical Laboratory Sciences; B.S., Univerisity of Idaho; M.S., Ph.D., University of Wisconsin.

Manlio LoConte, Physical Therapy; M.D., University of Padua.

Norma McQuaid, Clinical Nursing; R.N., St. Joseph's Hospital; B.S.N., Rivier College; M.S., C.A.G.S., Boston University.

David Morley, Physical Therapy; B.S., Queens University; M.D., Queens Medical School.

PROFESSIONAL SUPPORT STAFF

Robert Bishop, Clinical Medical Technology; M.T., (ASCP), B.A., Salem State College.

Nancy Grandbois, Clinical Medical Technology; M.T., (ASCP), B.A., B.S., Cedar Crest College; M.S., Northeastern University.

Nancy Peatman, Clinical Physical Therapy; B.S., University of Connecticut; M.Ed., Fitchburg State College.

Catharine Salerno, Clinical Medical Technology; M.T., (ASCP), B.S., M.S., University of Lowell.

Elizabeth Tavoularis, Clinical Nursing; R.N., B.S., Columbia University; M.S., Boston University.

CLINICAL FACULTY: DEPARTMENT OF CLINICAL LABORATORY SCIENCES

Lowell General Hospital

Donald C. Agostinelli, Chief Pathologist & Medical Director; M.D., Yale University School of Medicine.

Alan Cox, Clinical Medical Technologist-Coordinator; M.T., (ASCP), B.S., Iowa Wesleyan College.

Florence Hood, Clinical Medical Technologist—Hematology; M.T., (AMT), B.S., Merrimack College; M.S., University of Massachusetts.

Paul Inderbitzen, Clinical Medical Technologist—Blood Bank; M.T., (ASCP), B.S., Canisius College.

Olivia Li, Biochemist Laboratory; M.S., Ph.D., Biochemistry, Switzerland.

Margaret Nuttall, Clinical Medical Technologist—Microbiology; M.T., (ASCP), B.S., Southeastern Massachusetts University.

Melrose-Wakefield Hospital

Yvonne M. Glendon, Section Head—Hematology; M.T., (ASCP), B.S., Northeastern University.

William Lilly, Chief Pathologist & Clinical Supervisor; B.S., Marshall College; West Virginia University.

St. John's Hospital

Priscilla A. Fawcett, Instructor—Microbiology; M.T., (ASCP), B.S., Fitchburg State College.

Francine Gorman, Instructor Bacteriology/Serology; CLA, (ASCP), St. John's Hospital.

Audrey C. Hughes, Laboratory Coordinator; M.T., (ASCP), B.A., College of Notre Dame; M.D., M.A., Boston University.

Rita B. Keating, Supervisor-Instructor Blood Bank; M.T., (ASCP), B.S., Mt. St. Mary College.

Joyce A. Kempton, Supervisor—Blood Bank; CLA, (ASCP), St. John's Hospital.

Ann Marie Killeen, Education Coordinator; M.T., (ASCP), B.S., M.S., Rivier College.

Sharon L. Koning, Instructor; M.T., (ASCP), B.S., University of Vermont.

John R. Lethbridge, Supervisor-Microbiology; M.T., (ASCP), B.A., Gordon College; M.S., Long Island University.

Debra (Meece) Matthie, Instructor-Hematology; M.T., (ASCP), B.S., Northeastern University.

David M. McGoldrick, Pathologist, Director of Laboratory; M.D., Cornell University Medical School.

Karen Toscano, Hematology Supervisor; M.T., (ASCP), B.S., Southeastern Massachusetts University.

St. Joseph's Hospital

Sheryl Carter, Hematology Supervisor; B.S., Fitchburg State College; M.T., (ASCP), Newton-Wellsley Hospital.
Kathleen M. Gorczyca, Supervisor of Chemistry; M.T., (ASCP), B.S., University of Massachusetts.
Norman B. Harrison, Clinical Chemist; M.T., (ASCP), M.S., University of Bridgeport.
Susan Marquis, Blood Bank Supervisor; B.S., University of New Hampshire; M.T., (ASCP).

Mary Hitchcock Hospital

Robert C. Rodger, Chief Pathologist: M.D., Harvard University.
Sharon Ryan, Supervisor of Microbiology; M.T., (ASCP), B.S., University of Lowell.

Winchester Hospital

Marilyn J. Blunt, Supervisor of Bacteriology; A.A. Degree, Mount Ida Jr. College Medical Technology.
Helen. M. Deering, Supervisor of Chemistry; B.S., Framingham State College; M.T., (ASCP), Lawrence General Hospital School of Medical Technology.
Corinne A. Hartwell, Bench Technologist; M.T., (ASCP), B.S., Baldwin-Wallace College.
James H. Kiernan, Laboratory Supervisor; B.S., St. Francis Xavier University.
Patricia S. Scanlon, Blood Bank Laboratory Supervisor; M.L.T., (ASCP), B.S., Salem State.

Choate-Symmes Hospital

Geriann Flint, Blood Bank, M.T., (ASCP), Boston University.
James Grassi, Chief of Pathology; M.S., M.D., Tufts University.
Donna M. Sullivan, M.B.A., Anna Maria College.
Christine M. Werme, B.S., Southwestern Massachusetts University.

COLLEGE OF MANAGEMENT SCIENCE

The beginning of the twentieth century heralded the advent of an interdependent urban society in which business and business decisions became increasingly complex. The development of business theories, notably Taylor's scientific management, stressed the need for the study and research of business problems. In response, many of the nation's leading universities established schools of business. In the succeeding fifty years, these schools flourished. However, they tended to emphasize specific business problems and areas rather than generalized solutions. Their emphasis was primarily vocational. Students, for the most part, were prepared for a particular position in a particular industry.

In the late 1950s, the Carnegie Corporation and the Ford Foundation each sponsored separate studies of the state of collegiate education for business. The studies came to similar conclusions. They were critical of curricula that trained the students for narrow specialized tasks. They stressed the need for placing the major emphasis on analytical decision making in a rapidly changing economic environment. Their recommendations were influential in initiating critical self-studies by business schools. The resulting changes led to a fundamental change in business school curricula. Schools turned their attention from particular occupations and industries to the study of organizations. Emphasis was placed on developing analytical tools and techniques that could be applied to the solution of common administrative problems, be they in business, government, or non-profit organizations.

The improved quality of offerings made business graduates more valuable to employers. These employers include governmental bodies and non-profit organizations as well as private businesses. These factors, together with the growth of the economy, sharply increased the demand for accountants, applied economists, managers, and other business professionals. This trend is expected to continue well into the next century.

OBJECTIVES OF THE COLLEGE OF MANAGEMENT SCIENCE

The undergraduate and masters business programs offered by the College of Management Science are accredited by the American Assembly of Collegiate Schools of Business (AACSB).

The college is one of the larger collegiate schools of business in Massachusetts. In terms of publicly supported higher education for business, it is second only to the University of Massachusetts at Amherst. It seeks to provide its students with an education whose quality will enable them to function successfully as professionals in business and nonbusiness organizations. The key elements of a quality education are content and method. The faculty, through research consulting, and other scholarly activities, strive to keep pace with the rapidly changing subject matter in their fields, and utilize a variety of teaching methods with emphasis on the lecture and case method techniques.

In addition to its own majors, the college services other students at the University. The industrial technology program requires students to take a significant proportion of their courses in management science subjects. The College of Music's program in music business utilizes certain courses in business. Other students throughout the University are required or elect to take management science courses.

The college also participates in efforts to revitalize the region's economy. Faculty are encouraged to direct their research efforts toward regional business and economic issues. The resources and experience of the college are made available to assist in the solution of problems faced by business and governmental units in the Merrimack Valley.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Management Science is organized into four departments. It is administered by a dean, who is assisted by an advisory committee and an assistant dean. The departments are responsible for developing course offerings and programs of studies. The faculty of the college has overall responsibility for all academic policies of the college. The dean's advisory committee makes policy recommendations and also serves as a review body for suspended students seeking readmission with probationary status. The assistant dean administers the college on a day-to-day basis, with special attention to student affairs and registration.

BACCALAUREATE DEGREE PROGRAMS

The College of Management Science offers undergraduate programs leading to the degree of Bachelor of Arts, Bachelor of Science in Business Administration, and Bachelor of Science in Industrial Management. For details concerning graduate business programs, see the "Graduate School Catalogue."

Bachelor of Arts

The Bachelor of Arts degree is offered with a major in economics. This degree program provides opportunities for pursuing an economics major within the context of more flexible curriculum requirements than are permitted for economics students who pursue the professional degree of Bachelor of Science in Business Administration. University requirements concerning the Bachelor of Arts degree are stated elsewhere in this publication under the headings "Academic Policies: Baccalaureate Degrees" and "Academic Policies: Major Field Requirements."

Bachelor of Science in Business Administration

The Bachelor of Science in Business Administration degree is designed to provide students with a foundation in the liberal arts and sciences, as well as the analytical skills and specialized professional courses which will enable them to function as effective professional administrators in business. Course work in the first two years focuses on the liberal arts, sciences, and introductory professional skills courses. These subjects provide the foundation on which the advanced courses are built. In the liberal arts and sciences, emphasis is upon written English, the behavioral sciences (psychology and sociology), science, and mathematics—including an introductory computer course. The professional skills courses include accounting, economics, and statistics. During the last two years, students take professional courses in business law, finance, government and business, marketing, operations management, management information systems, and business policy. In addition, students select program options in accounting, economics, marketing, or management. An international business course is required of all management, marketing, and economics students; it may be in business law, marketing, finance, economics, or management. Regardless of department options elected, students have sufficient electives to permit them to tailor their programs to their special interests.

Bachelor of Science in Industrial Management

The degree of Bachelor of Science in Industrial Management is designed to provide students with a specialized education in technological and management areas. The program includes many courses offered by the College of Engineering.

GENERAL COLLEGE REQUIREMENTS

Each candidate for an undergraduate degree must satisfy the general University requirements for graduation and must complete all requirements as specified by one of the established curricula within the college.

Due to the structured nature of the baccalaureate programs in business administration and industrial management, students who matriculate in other colleges of the University may not minor in business or industrial management. These students may minor in economics, or may elect certain management science courses. They may also elect a second major in the College of Management Science provided they also complete all related requirements as specified by the concerned department of the College of Management Science.

Residency Requirement

In addition to the minimum University residency requirements, the College of Management Science requires the senior year work, with minor exceptions, to be taken in residence at the College of Management Science.

Declaration of Program (Business Administration or Industrial Management) and Major (Economics)

Students enrolled in the College of Management Science, of necessity, are committed to pursue one of the established college programs and are required to declare their choice of degree program upon enrollment. Students pursuing the Bachelor of Science in Business Administration degree pursue a core program for the first two years and are required to declare a concentration by the end of the sophomore year. In any event, all students are required to file specific declarations of degree programs and/or concentration with the office of the registrar no later than the beginning of their junior year. Students enrolled in the College of Liberal Arts who wish to elect a second major in economics, or to minor in economics, must secure the approval of the chairperson of the Department of Economics prior to making such a declaration and must file the appropriate University form with the office of the registrar no later than the end of the sophomore year. During the first semester of their senior year, students are required to file a Declaration of Intention to Graduate (DIG) form with their major advisor or major department's designated DIG officer.

Change of Major

Bachelor of Arts degree candidates in the College of Management Science may drop the economics major by withdrawing from the University, transferring to another college of the University, or changing their degree program to the Bachelor of Science in Business Administration or the Bachelor of Science in Industrial Management. Students who wish to change their major and degree program within the College of Management Science must secure the approval of the chairperson of the appropriate (receiving) department of the college. Students who wish to drop their program or major in the College of Management Science and elect a major offered by another college of the University should consult the policy concerning intercollegiate transfer within the University which appears elsewhere in this publication in the section "University Academic Policies" under the heading "Major Field Requirements." All such changes of program require notification of the office of the registrar through the filing of the form for declaration of major or change of major. Students who withdraw from the University must do so through the office of the registrar. Bachelor of Arts degree candidates may change their minor studies when changing their majors and may substitute alternative minor programs without changing majors. Such changes are subject to the established regulations of the colleges in which such studies are pursued. Additional course work beyond the minimum 120 credits, and extension of the normal four-year period of study, may be expected for students who change their major options later than the first semester of their junior year or who change their degree program later than the end of the freshman year.

Students who are candidates for the Bachelor of Science in Business Administration may change their degree programs when they have received the permission of the chairperson of the appropriate (receiving) department. Students may transfer from another college to the College of Management Science, but are advised that openings may be limited or unavailable in some programs, that differential admissions criteria may be applied to program or college applicants when staffing or facilities render it necessary to establish limitations upon enrollments, and that the completion of degree requirements within the customary four-year period may not be possible, particularly if the transfer takes place after the second semester of the sophomore year.

Transfer Policies

Students transferring to the College of Management Science from other colleges of the University or from other accredited institutions may expect recognition of previously completed courses if these are equivalent to those specified by the curricula of the college.

Transfer from Other Institutions

Courses which are transferred from other institutions are initially evaluated by the office of admissions in terms of general University requirements when a student is admitted to the University and are also evaluated by professional departments in terms of college and program requirements at the time a student is accepted for matriculation in the College of Management Science. Courses which are transferred to the University under provisions of the Commonwealth Transfer Compact, and which are not creditable to requirements of the College of Management Science or as unrestricted elective courses, will be listed on the student's permanent record card but will not apply to the minimum degree requirements. In the event that a student who has transferred to the University under the Commonwealth Transfer Compact subsequently makes an intercollegiate transfer to the College of Management Science, all previously completed courses, including transferred courses from the compact institution, will be reevaluated in terms of their applicability to degree requirements of the College of Management Science.

The applicability of grades received in transferred courses for the determination of the grade-point average of the student's major at the University of Lowell is determined by policies of each of the colleges. The policy of the College of Management Science is not to count such grades for the purpose of determining the student's major grade-point average.

Repetition of Transferred Courses

A student who has been granted transfer credit, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred when the competence of the student has been demonstrably inadequate. Permission to repeat a transferred course is granted by filing an academic petition form through the office of the college dean. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

Intercollegiate Transfer to the College of Management Science

Students wishing to transfer from another college of the University, or from continuing education programs of the Evening School, must have successfully completed 15 credits at the University with a cumulative grade-point average of not less than 2.0 and must file a petition, together with a transcript of their permanent record cards, with the appropriate chairperson and the dean of the College of Management Science by November 1 for spring semester transfer and by April 1 for fall semester transfer. Students are referred to University policies concerning intercollegiate transfer which appear elsewhere in this publication under the heading "Academic Policies: Change of Major with Intercollegiate Transfer" for further procedural details. Records of students who are approved for transfer are reviewed by the office of the dean and all courses which may not be applied to college or program requirements, irrespective of grades previously received in other college programs, are deleted from the student's cumulative grade-point average.

Special Academic Policies

The following specific restrictions on programs of the College of Management Science are peculiar to this college, and all students must be aware of them:

1. Upper division courses (300/400 level) are, first, absolutely restricted to matriculated students who have completed at least sixty (60) credits before entry into these courses. Transfer students may not count within the 60 credits any courses that require validation; that is, courses that they may have taken as freshmen or sophomores at other institutions that the College of Management Science offers in its upper division (junior and senior years). Second, these upper division courses are, generally, restricted to:

   a. Students of the College of Management Science.

   b. Those students of other colleges whose present major requires the completion of specific business or economics courses; and,

   c. Students in the economics minor.

2. The College of Management Science requires that all of its upper division courses (those prefixed 60, 62, 64, and 66) must be taken in the day program. Those students who cannot complete their studies in the day program must transfer to the Evening School; a terminal date of 1987 has been set for completion of baccalaureate business programs in the Evening School.

3. Students of the College of Management Science who wish to invoke the grade substitution rule must repeat these courses in the day program.

4. The College of Management Science does not allow a completely unrestricted choice of electives to be taken as general electives. Courses that are restricted to students in a certain major, courses that another college describes as nontransferable, and courses that are inherently technical or professional in nature

may not be used as general electives. Courses with the following prefixes may not be credited to College of Management Science students as area distribution or general electives:

01-07; 10-12; 14, 16, 18, 20 (except for students in the BSIM major or the MG/OP option); 22, 24, 25, 26, 28 (except for students in the BSIM major); 31-39; 91 (except for students undertaking the mathematics minor/computer science option); 97, and 98. Only the following courses from the College of Music may be accepted: 74-161, 74-261, and 74-465.

Contract Learning Program

Through contract learning, the student is provided with an opportunity to learn more about various professional fields within the College of Management Science. To qualify, a student must have a grade-point average of at least 2.50 and must be a second semester junior. The heart of the program rests in the contract drawn by the student and presented to a faculty sponsor. The student submits an outline of the project to be pursued to a faculty sponsor. The proposal includes a statement of the relationship of the proposed project to a theory or technique applicable to a student's major. For further information, students should refer to policies which appear elsewhere in this publication under the heading "Academic Policies: Cooperative Education" and should consult with their department chairpersons.

INDUSTRIAL MANAGEMENT

The industrial management curriculum combines the elements of a program in operations management with a basic foundation in engineering. The first two years provide a sound education in English, mathematics, the physical sciences, mechanical engineering, economics, accounting, and statistics. The junior and senior years are devoted to professional business courses. The industrial management graduate is equipped to assume managerial and administrative responsibilities in technologically-oriented firms through the management of complex production activities or the marketing of specialized mechanical or electrical equipment.

COURSE OF STUDY FOR INDUSTRIAL MANAGEMENT
(Bachelor of Science in Industrial Management)

Freshman Year

Fall Semester		Spring Semester	
20-105 Intro to Mech. Design* (with laboratory)	3	42-102 College Writing II	3
		64-202 Economics II	3
42-101 College Writing I	3	92-132 Calculus B-II	4
64-201 Economics I	3	95-144 Physics II	3
92-131 Calculus B-I	4	96-144 Fund. of Exp. Physics II	1
95-141 Physics I	3	39-200 Physical Education	0.5
96-141 Fund. of Exp. Physics I	1	39-200 Physical Education	0.5
39-100 Physical Education	0.5		
39-100 Physical Education	0.5		
	18		15

* 25-101, Introduction to Engineering Design and Graphics, may be substituted (both lecture and lab required) - 2 credits.

Sophomore Year

Fall Semester	
20-112 Machine Tool Processes (with laboratory)	3
60-201 Acctg. Prin. I	3
64-211 Statistics I	3
84-121 Chemistry I	3
84-123 Chemistry I Lab	1
92-231 Calculus B-III	4
	17

Spring Semester	
42-224 Business Writing	3
60-202 Acctg. Prin. II	3
64-212 Statistics II	3
84-122 Chemistry II	3
84-124 Chemistry II Lab	1
92-234 Differential Equations	3
	16

Junior Year

Fall Semester	
22-214 Eng. Mechanics I**	4
25-295 Materials Science	3
62-301 Marketing Principles	3
66-331 Business Finance	3
66-371 Operations Management I	3
	16

Spring Semester	
Area I Elective	3
20-416 Stat. Quality Control	3
60-362 Business Law I	3
92-242 Intro. to Computers	3
Area II Elective	3
	15

Senior Year

Fall Semester	
16-211 Fund. of Electricity	3
66-353 Organizational Behavior	3
66-404 Computer Applications	3
66-473 Operations Analysis Techniques	3
Area I Elective	3
	15

Spring Semester	
22-347 Elements of Thermo and Heat Transfer	3
64-307 Gov't., Bus. and Society***	3
66-498 Business Policy	3
Int'l. Elective	3
Area II Elective	3
	15

** 22-215, Mechanics, may be substituted.

*** 60-365, Law and Society, may be substituted for 64-307.

DEPARTMENT OF ACCOUNTING

Chairperson: Clairmont P. Carter

Professors: William Burke, Clairmont Carter, Gerald Downey, Charles Feeney, Linda Kistler

Associate Professors: Samuel Chesler, J. Stephen Collins, Michael Jones, Russell Karl, Charles Thompson, Daniel Verreault, Kathryn Verreault

Assistant Professors: John Hamer, Brook Hargreaves-Heald, Daniel Jones, Anne Koen, Patrick McNally, Kathy Stevens

Instructors: Kathy Dow, Judith Harris

Accounting Concentration (Bachelor of Science in Business Administration)

The fundamental objective of the accounting concentration is to prepare students for professional positions in management accounting and public accounting. The program offers a rigorous preparation for professional careers by providing concentrations to fit the needs of a diverse student body in the College of Management Science.

The accounting discipline is intended to provide students with quantitative skills necessary for developing financial information for management, and to enable them to carry out fundamental activities of professional accountants; data accumulation, analysis, and interpretation, together with the communication of results. The specialties within the accounting concentration at the University of Lowell are designed to prepare graduates for service in a dynamic and respected profession.

The concentrations available within the accounting concentration are as follows:

Management Accounting Option

Students desiring to pursue careers in private industry should enroll in accounting courses designed to prepare them for managent positions in industrial accounting. Courses in cost accounting, budgeting and standard costs, controllership, and financial analysis are emphasized. Students are encouraged to complete elective courses in finance as well as accounting in order to offer as broad a background as possible in subjects which are encountered in a private enterprise environment.

Public Accounting Option

Students interested in public accounting careers are expected to enroll in courses to prepare them for specialized activities in auditing, management information systems, and taxation. Because of the intense competition for positions in public accounting firms, students selecting this option are expected to demonstrate high standards of academic achievement as well as a firm commitment to public accounting careers. Senior students are encouraged to sit for the CPA examination in May prior to their graduation in June.

Law Courses Within the Accounting Department

Accounting students interested in the legal system have the opportunity to take three law courses after completing 60-362 Business Law I—Contracts and Agency. These courses are especially recommended for students planning to take the CPA Examination, or those who are interested in international legal issues.

COURSE OF STUDY FOR BUSINESS ADMINISTRATION: ACCOUNTING CONCENTRATION
(Bachelor of Science in Business Administration)

Freshman Year

Fall Semester			Spring Semester		
42-101	College Writing I	3	42-102	College Writing II	3
47-101	General Psychology	3	48-101	Sociology	3
92-121	Pre-Calculus Mathematics	3	92-122	Differential Calculus	3
	History or Political Science Elective	3		History or Political Science Elective	3
	Science Elective*	3-4		Science Elective	3-4
39-	Physical Education	1	39-	Physical Education	1
		16-17			16-17

* One of the two science electives must be a laboratory science.

Sophomore Year

Fall Semester	
60-201 Accounting Principles I	3
64-201 Economics I	3
64-211 Statistics I	3
92-201 Integral Calculus	3
Area II Elective	3
	15

Spring Semester	
60-202 Accounting Principles II	3
64-202 Economics II	3
64-212 Statistics II	3
92-202 Micro Computers and Application's Software	3
42-224 Business Writing	3
	15

Junior Year

Fall Semester	
60-301 Intermediate Accounting I	3
60-321 Cost Accounting I	3
60-362 Business Law I	3
66-321 Marketing Principles	3
66-331 Business Finance	3
	15

Spring Semester	
60-302 Intermediate Acct. II	3
60-365 Law and Society**	3
60-322 Profit Planning and Control	3
66-353 Organizational Behavior	3
66-332 Money and Banking	3
	15

Senior Year

Fall Semester	
60-401 Advanced Fin. Acctg.	3
60-454 Acctg. Info. Systems	3
66-371 Operations Mgmt. I	3
Area II Elective	3
General Elective	3
	15

Spring Semester	
60-431 Federal Income Taxes	3
66-498 Business Policy	3
60- Accounting Elective	3
Area I, II, or III Elective	3
General Elective	3
	15

** 64-307 Government, Business, and Society may be substituted for 60-365

Accounting (Course Prefix: 60)

60-201 ACCOUNTING PRINCIPLES I **I(3,0)3**

Presents a comprehensive and detailed exposure to basic accounting theory. Beginning with the accounting equation, the student is introduced to the accounting cycle, preparation of the statement of financial position and the income statement, and accounting for the assets of the firm.

60-202 ACCOUNTING PRINCIPLES II **II(3,0)3**

Emphasizes the accounting for corporations, treatment of stockholders' equity, earnings and dividends. Examines the statement of changes in financial position, cash flow causes and effects, and financial statement analysis. Prerequisite: 60-201.

60-301 INTERMEDIATE ACCOUNTING I **I(3,0)3**

This course examines the generally accepted accounting principles relating to the preparation of financial statements. The student will study, in depth, the valuation and disclosure problems associated with the assets of the firm. Prerequisite: 60-202.

60-302 INTERMEDIATE ACCOUNTING II **II(3,0)3**

This course continues the in-depth study of the valuation and disclosure problems associated with corporate liabilites and stockholders' equity. Emphasis is placed on the pronouncements of the Financial Accounting Standards Board. Prerequisite: 60-301.

60-311 MANAGERIAL ACCOUNTING **I(3,0)3**

An in-depth examination of the use of accounting systems for managerial decision making. Budgeting, forecasting, and cost accumulation systems which relate to the manufacturing firm will be studied. (For non-accounting majors) Prerequisite: 60-202.

60-321 COST ACCOUNTING I **I(3,0)3**
An examination of the manufacturing function from the view of the cost accountant. Managerial control of the elements of product costs will be studied with an emphasis on cost accumulation systems both historical and estimated. Prerequisite: 60-202.

60-322 PROFIT PLANNING AND CONTROL **II(3,0)3**
Topics covered will include standard costs, variance analysis, profit planning, cost-volume-profit analysis, and relevant cost analysis for problems solving. Prerequisite: 60-321.

60-362 BUSINESS LAW I—CONTRACTS AND AGENCY **I,II(3,0)3**
This course introduces the student to the fundamentals of criminal and tort law. The main emphasis is on all aspects of contract law including the agreement, consideration, the writing, third party rights, illegality, performance, and remedies. Also covered is agency law concerning all situations where one party is working for another in the business world.

60-363 BUSINESS LAW II—LEGAL ENTITIES **I,II(3,0)3**
This course continues the study of law and its impact on the business world. Partnerships, limited partnerships, and joint ventures are studied at the outset of the course. The main emphasis is on elements of the corporate structure. The last part of the course deals with personal and real property with coverage of wills and trusts. Prerequisite: 60-362.

60-364 BUSINESS LAW III—THE COMMERCIAL CODE **I(3,0)3**
This course is recommended for the senior level student especially those studying for the C.P.A. exam. It deals exclusively with the Uniform Commercial Code including sales, bills and notes, secured interests, and bulk sales. Prerequisites: 60-362, 60-363 or permission of instructor.

60-365 LAW AND SOCIETY—THE LEGAL ENVIRONMENT OF BUSINESS **I(3,0)3**
This course deals with the manager's role in understanding and determining the firm's relations with government and society. Topics relating to government include the tax and regulatory provisions of local, state and federal agencies including such matters as antitrust, mergers and licensing. Topics relating to society include the social cost of business, civil rights, business ethics, and problems in ecology.

60-366 INTERNATIONAL LAW **II(3,0)3**
This course is recommended at the senior level. This course covers the international legal process including the sources of international law and its history. It covers specific problems in international law such as war prevention, economic well being, environmental considerations and socio-political justice. It further explores legal perpectives of law and global reforms as well as the promotion of humane world order values. Prerequisite: 30-362 or permission of instructor.

60-401 ADVANCED FINANCIAL ACCOUNTING I **I(3,0)3**
This course explores theoretical and practical problems in accounting for large, multicorporational business entities. Consolidation, mergers, and home office/branch accounting receive in-depth study. Prerequisite: 60-302.

60-402 ADVANCED FINANCIAL ACCOUNTING II **II(3,0)3**
This course offers a comprehensive study of partnership accounting, accounting for installment and consignment sales, and also includes an introduction to accounting for non-profit organizations (government, educational units and hospitals). Prerequisite: 60-401.

60-421 AUDITING I **I(3,0)3**
An examination of purposes of financial and operations auditing. The following topics will be examined in depth: auditing standards, professional ethics, legal responsibilities, internal control, audit evidence, financial statement disclosures, audit reports, management advisory services, and internal auditing. Prerequisite: 60-454.

60-423 FINANCIAL ACCOUNTING THEORY AND PRACTICE **I(3,0)3**
Prepares students for various parts of the C.P.A. exam. Only those interested in a career in public accounting should enroll.

60-424 INTERNATIONAL ACCOUNTING **I(3,0)3**
This course deals with the differences in accounting theory and practice among the major industrial countries with emphasis on inflation, transfer pricing and fundamental differences in generally accepted accounting principles. Prerequisite: 60-362.

60-431 FEDERAL INCOME TAXES **I(3,0)3**
This course deals with the basic rules and regulations of the Internal Revenue Code as it affects the individual and the corporation. An understanding of the code is developed through lectures, assigned readings, research, and the solution of a wide variety of problems. Prerequisite: 60-202.

60-432 ADVANCED FEDERAL TAXATION **II(3,0)3**
This course deals with the rules and regulations of the Internal Revenue Code as it affects corporations, estates and trusts. Emphasis will be on special corporate problems including incorporation, distributions and liquidations. Prerequisite: 60-431.

60-441 ACCOUNTING FOR NOT FOR PROFIT INSTITUTIONS **I(3,0)3**
Examines financial accounting methods, principles and systems, as related to state, county and local governments, colleges and universities, and hospitals. While fund accounting concepts provide the general framework of the course, expenditure controls are given particular attention through an examination of appropriation and encumbrance accounting. This course is appropriate for students intending to become certified public accountants and those who have an interest in working for service related institutions in the nonprofit section of the economy. Prerequisite: 60-302.

60-451 CONTROLLERSHIP **I(3,0)3**
Functions and procedures of the controller in modern business. Emphasis upon control systems which safeguard assets and assist in efficient utilization of the firm's resources. Special attention is placed upon long-range operational planning and control. Prerequisite: 60-302.

60-454 ACCOUNTING INFORMATION SYSTEMS **I(3,0)3**
This course provides an analysis of modern management information systems. Topics include the design, implementation, and evaluation of information systems, including computer applications. Prerequisite: 60-302.

60-499 RESEARCH SEMINAR **(3,0)3**
Designed for upperclass accounting majors who wish to do research and/or investigate special topics of interest in accounting. This course may also be utilized to offer topics to individual students when there are too few registrants for a regular course. Prerequisite: Permission of the department chairperson.

DEPARTMENT OF MARKETING

Chairperson: Braxton Hinchey

Professors: Leslie M. Dawson, Braxton Hinchey, Stuart L. Mandell (Emeritus), Irwin A. Shapiro
Associate Professors: Ralph A. Rieth

Assistant Professors: Claire L. Comm, Lucy L. Henke

Instructor: Harvey J. Ames

The Department of Marketing offers a concentration within the degree of Bachelor of Science in Business Administration.

Marketing Concentration (Bachelor of Science in Business Administration)

The American Marketing Association defines marketing as " . . . the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational objectives."

Students electing the marketing concentration should first complete the College of Management Science common freshman-sophomore core requirements. The first course in marketing is open only to students who have completed at least 60 accepted credits toward their degree.

The marketing concentration requires three junior level courses, Marketing Principles (62-301), Marketing Research (62-302), and International Marketing (62-303). In the senior year, marketing students take two marketing electives and Marketing Management (62-423).

COURSE OF STUDY FOR BUSINESS ADMINISTRATION: MARKETING CONCENTRATION

(Bachelor of Science in Business Administration)

Freshman Year

Fall Semester			Spring Semester		
42-101	College Writing	3	42-101	College Writing II	3
	History or Political Science Elective	3		History or Political Science Elective	3
47-101	General Psychology	3	48-101	Sociology	3
	Science Elec. (w/lab)	4		Science Elective	3
92-121	Precalculus	3	92-122	Differential Calculus	3
39-	Physical Education	0.5	39-	Physical Education	0.5
39-	Physical Education	0.5	39-	Physical Education	0.5
		17			16

Sophomore Year

Fall Semester			Spring Semester		
60-201	Acct. Principles I	3	42-224	Business Writing	3
64-201	Economics I	3	60-202	Acct. Principles II	3
64-211	Statistics I	3	64-202	Economics II	3
92-201	Integral Calculus	3	64-212	Statistics II	3
	Area II Elective	3	92-202	Micro Computers and Applications Software	3
		15			15

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	62-302 Marketing Research	3
66-371 Operations Management	3	62-303 Int'l. Marketing	3
General Elective*	3	64-307 Gov't. Bus. and Society**	3
	15		15

Senior Year

Fall Semester		Spring Semester	
62- Marketing Elective	3	62-423 Marketing Management	3
62- Marketing Elective	3	66-404 Computer Applications	3
Area II Elective	3	66-498 Business Policy	3
General Elective	3	General Elective	3
General Elective	3	Area I, II, or III Elec.	3
	15		15

* Classes of 1987 and 1988 only; for Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

Marketing (Course Prefix: 62)

The marketing faculty strongly recommends that students in the marketing program devote a significant number of their area and general electives to the study of history and foreign language.

62-301 MARKETING PRINCIPLES **I(3,0)3**
The role of marketing in the economy. The elements of the marketing mix; product, price, distribution, and promotion; are discussed in the context of social and political constraints on marketing activity. Prerequisite: 64-201.

62-302 MARKETING RESEARCH **II(3,0)3**
Analysis of the information gathering function of marketing management. Design execution and evaluation of marketing research. Credit not given to students who have taken 66-356. Prerequisites: 62-301, 64-211.

62-303 INTERNATIONAL MARKETING **II(3,0)3**
The marketing aspect of international business. Cultural dynamics, economics, political and legal constraints as they affect international marketing institutions and practices. Prerequisite: 62-301.

62-401 ADVERTISING **II(3,0)3**
Paid, identified use of media to inform and persuade. Research, copy writing, scheduling and budgeting from the point of view of the marketing manager. Prerequisite 62-301.

62-402 CONSUMER BEHAVIOR **II(3,0)3**
Application of the theories and techniques from the behavioral sciences to the understanding of consumer problem identification and purchasing processes. Prerequisites: 47-101, 48-101, 62-301.

62-403 INDUSTRIAL MARKETING **II(3,0)3**
Special problems in marketing industrial goods. Distribution channels, pricing policies, product line planning and promotional strategy for companies marketing to industrial firms, governmental agencies and other organizations. Prerequisite: 62-301.

62-404 PHYSICAL DISTRIBUTION MANAGEMENT **I(3,0)3**
Social and economic aspects of transportation problems as revealed by analysis of the nature, history, and problems of the American transportation industry. Management of the distribution function: warehousing, inventory control, materials handling and industrial packaging. Prerequisites: 66-371 and 62-301.

62-405 SALES MANAGEMENT **I(3,0)3**
Management of the personal selling function. Principles of sales force organization, selection, training, compensation, supervision and motivation are explored via appropriate cases. Prerequisite: 62-301.

62-406 PURCHASING AND MATERIALS MANAGEMENT **I(3,0)3**
Purchasing procedures, inventory control, quality control, source selection, forward buying and speculation for the production enterprise. Prerequisite: 62-301 or permission of instructor.

62-407 RETAILING **I,II(3,0)3**
Development, organization and management of various types of retailing institutions. Evaluation of retail locations and contemporary retailing problems. Prerequisite: 62-301 or permission of instructor.

62-423 MARKETING MANAGEMENT **II(3,0)3**
Formulation, implementation and control of the firm's marketing strategies and plans. Case study of the behavioral, quantitative and environmental aspects of marketing decision-making. Prerequisites: Senior standing in marketing.

62-494 FOREIGN AREA ANALYSIS **I,II(3,0)3**
Independent study leading to an in-depth environmental analysis of a selected country or region. Prerequisite: Senior standing and permission of instructor.

62-496 SPECIAL TOPICS IN MARKETING **I,II(3,0)3**
Senior seminar covering marketing topics not typically addressed in regularly scheduled courses. Prerequisite: permission of instructor.

62-497 HONORS PROSEMINAR **I,II(6,0)6**
Preparation and defense of senior honors thesis in Marketing. Prerequisite: Permission of Honors Program coordinator. NOTE: This must be elected for two consecutive semesters.

62-498 MULTINATIONAL BUSINESS POLICY **I,II(3,0)3**
Integration of knowledge from the various functional areas of business administration toward solution of problems affecting the character and success of the total enterprise. Point of view of chief executive officer operating in an international setting.

62-499 RESEARCH SEMINAR **I,II(3,0)3**
An opportunity for students to perform substantive research in an area of special interest under the supervision of a member of the marketing faculty. This course may be used as a concentration elective. It may also be used to offer topics to individual students when there are too few registrants for a regular class. Prerequisite: Permission of department chairperson.

DEPARTMENT OF ECONOMICS

Chairperson: Paul Snoonian

Professors: Albert Cederlund, Benjamin Chinitz, Thomas Macbeth, Carol McDonough

Associate Professors: Harrison Campbell, George Dery, Susan Goodwin, Richard Healy, Ernesto Sanz, Balbir Sihag, Paul Snoonian

Assistant Professors: Michael Carter, H. Michael Coiner, Satya Dutta, Ralph Gentile, Ellee Koss, Supriya Lahiri, Philip Moss, Bong Yang

Visiting Professor: Eliahu Romanoff

The Department of Economics offers a program which leads to the degree of Bachelor of Arts with a major in economics; an economics concentration within the Bachelor of Science in Business Administration major; and a minor in economics for students of other colleges.

Economics Major (Bachelor of Arts)

Economics as a discipline is concerned with the principles underlying the production and exchange of products and services. The study of economics stems from the scarcity of resources and the limitless nature of our demands for products and services. Societies must therefore choose the goods and services which will be produced from among the larger range of production possibilities. Economics develops the principles and concepts which follow from this fact of scarcity and applies them to the analysis of various aspects of human activity that require us to choose from competing alternatives.

The economics major completes a sequence of fundamental economics courses and economics electives which provide a sound knowledge of economic concepts and analyses. The introductory courses survey economic problems, policies, and theory. Required courses in microeconomic and macroeconomic theory and in statistics provide a deeper analytical foundation and the necessary quantitative tools. Economics electives provide students with opportunities to explore subject areas that are of personal interest and consistent with their career objectives. The major in economics must include, at a minimum, the following courses:

64-201	Economics I	3
64-202	Economics II	3
64-211	Statistics for Business and Economics I	3
64-212	Statistics for Business and Economics II	3
64-303	Microeconomic Theory	3
64-304	Macroeconomic Theory	3
	Economic electives (minimum requirement)*	12
		30

* At least 9 credits must be taken at the 300 or 400 levels.

Economics majors will be counseled by their faculty advisors to select a minor area of studies or a program of elective courses from such related disciplines as political science, history, sociology, accounting, management, or mathematics.

Details concerning requirements for minor programs are provided in those other sections of this bulletin that describe course offerings of the several colleges of the University, and these should be consulted by students contemplating minor programs which are not offered by the College of Management Science. Minor programs consist of 18-24 semester credits of courses specified by concerned departments; all include at least 6 credits of courses which are on or above the 300 level.

Economics Concentration (Bachelor of Science in Business Administration)

The economics concentration is designed to provide a strong background in economic theory and applied economic analysis, within the framework of a business education. In the first two years, the program expands the student's knowledge of mathematics and the liberal arts and introduces him/her to economics, accounting, and statistics. During the third and fourth years, the student pursues those areas of study which are of particular interest and are consistent with his/her career objectives; the study of economics is complemented by courses in management, finance, business law, and the humanities.

The goals of the economics concentration are to provide a sound, working knowledge of economics, preparation for a career in business, and a foundation for graduate study. Since the concentration equips the student with the techniques of business analysis and problem solving, a graduate is equipped for employment in a variety of fields in business and government. The program is also recommended for students planning graduate study in economics, business, and law.

Economics Minor*

Students matriculating for degree in other colleges of the University may elect the following program when policies of the colleges in which they are matriculating permit. All minor programs of the University require 18-24 credits and a minimum of 6 credits on the 300 level or above.

64-201	Economics I	3
64-202	Economics II	3
	Four (4) Economics Electives	12
		18

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* Not available to students in the College of Management Science.

COURSE OF STUDY FOR BUSINESS ADMINISTRATION: ECONOMICS CONCENTRATION
(Bachelor of Science in Business Administration)

Freshman Year

Fall Semester			Spring Semester		
42-101	College Writing I	3	42-102	College Writing II	3
	History or Political Science Elective	3		History or Political Science Elective	3
47-101	General Psychology	3	48-101	Sociology	3
92-121	Pre-Calculus	3	92-122	Differential Calculus	3
	Science Elec. (w/lab)	4		Science Elec.	3
39-	Physical Education	0.5	39-	Physical Education	0.5
39-	Physical Education	0.5	39-	Physical Education	0.5
		17			16

Sophomore Year

Fall Semester		Spring Sementer	
60-201 Acct. Principles I	3	42-224 Business Writing	3
64-201 Economics I	3	60-202 Acct. Principles II	3
64-211 Statistics I	3	64-202 Economics II	3
92-201 Integral Calculus	3	64-212 Statistics II	3
Area II Elective	3	92-202 Micro Computers and Application’s Software	3
	15		15

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-362 Business Law	3
64-303 Microeconomic Theory	3	64-304 Macroeconomic Theory	3
66-331 Business Finance	3	64-307 Gov’t., Bus., & Society*	3
66-353 Organizational Behavior	3	64- Economics Elective	3
66-371 Operations Management I	3	66-332 Money & Banking	3
	15		15

Senior Year

Fall Semester		Spring Semester	
64-407 Econometrics	3	66-498 Business Policy	3
64- Economics Elective	3	64- Economics Elective	3
Int’l. Elective	3	CMS Elective	3
Area II Elective	3	General Elective	3
General Elective**	3	Area I, II, or III Elec.	3
	15		15

* 60-365 Law and Society, may be substituted for 64-307

** Classes of 1987 and 1988 only; for Class of 1989 et seq., 66-405, Management Information Systems

Economics (Course Prefix: 64)

64-200 ECONOMIC ANALYSIS **(3,0)3**

A one semester introduction to the principles of economics. Topics covered include: an introduction to supply, demand, pricing, and output under alternative structures; a study of the factors governing the level of natural income and employment; an introduction to central banking and international finance. No credit for CMS students.

64-201 ECONOMICS I **I(3,0)3**

A study of the principles of production and exchange. An introduction to demand, supply, pricing and output under alternative market structures. Derived demand and resource markets are introduced.

64-202 ECONOMICS II **II(3,0)3**

A study of the principles governing the level of national income and employment. Examination of the commercial banking system, monetary and fiscal policy, the international economy, and alternative economic systems. Prerequisite: 92-122 or equivalent.

64-211 STATISTICS FOR BUSINESS AND ECONOMICS I **I(3,0)3**

Descriptive statistics, sophisticated counting techniques and other components of probability, simple random variables and their distributions, bivariate functions, sampling theory properties of estimators.

64-212 STATISTICS FOR BUSINESS AND ECONOMICS II **II(3,0)3**

Interval estimation, hypothesis testing, analysis of variance, applied regression theory, correlation analysis, and other selected topics. Prerequisite: 64-211, 92-201.

64-302 LABOR ECONOMICS **(3,0)3**
The effect of American capitalism on the position of labor. The rise of union organization and the factors in its growth. Trends in the labor force, money and real wages, wage problems and wage differentials, problems of hours and working conditions, and causes and remedies for unemployment. Prerequisites: 64-201, 64-202.

64-303 MICROECONOMIC THEORY **I(3,0)3**
An advance examination of price and production theory, the theory of the consumer and the firm. Prerequisite: 64-201.

64-304 MACROECONOMIC THEORY **II(3,0)3**
An analysis of Keynesian and post-Keynesian theory. National income accounts, monetary and fiscal policy, and econometric models. Prerequisite: 64-202.

64-306 URBAN ECONOMICS **I(3,0)3**
An introduction to urban economics. Analysis of intrametropolitan spatial relationships including location, land use and housing markets. Prerequisites: 64-201 or 64-202.

64-307 GOVERNMENT, BUSINESS AND SOCIETY **I,II(3,0)3**
An examination of various governmental and nongovernmental controls on business and nonprofit organizations. Emphasis is placed on the impact of laws, court interpretations, economic theories, social and political philosophies, and ethical considerations on these organizations. Students will have an opportunity to examine business decisions which involve questions of value and choice. Prerequisite: 64-201.

64-310 ECONOMIC DEVELOPMENT OF LESS DEVELOPED COUNTRIES **II(3,0)3**
The role of capital/private and social technology, labor governments, international trade and sociocultural and institutional factors in development. Analysis of capital output ratios, social marginal product, disguised unemployment and overpopulation theories. Critical analysis of development strategies. Prerequisite: 64-201.

64-312 MANAGERIAL ECONOMICS **I,II(3,0)3**
Economic theory and statistical methods applied to business decision making. Estimation of demand, production, cost functions and accompanying elasticity estimates, pricing and output decisions, value maximization problems, and capital budgeting. Prerequisites: 64-201, 64-202, 64-212.

64-315 BUSINESS AND ECONOMIC FORECASTING
This course develops the fundamentals of forecasting for managerial decision making. Topics covered are data collection, review of basic statistical concepts and computerized forecasting techniques. The forecasting models developed include averaging, smoothing, time series, correlation, and regression. Prerequisite: 64-211.

64-319 TOPICS IN LATIN AMERICAN ECONOMICS **(3,0)3**
Problems faced by the developing countries of Latin America with respect to population, agricultural reform, industrialization, and economic growth. Prerequisites: 64-201 or 64-202.

64-381 PERSONAL ECONOMIC PLANNING **I(3,0)3**
The study of personal economic planning is divided into the following areas: economic principles underlying the concepts of saving, investing, insurance and risk management at the household level; products currently available for use in personal economic planning; development of a framework for use in the application of basic principles to the economic decision-making process necessary for good planning. Prerequisites: 64-201, 64-202.

64-403 INTERNATIONAL TRADE THEORY **II(3,0)3**
The classical and modern theories. International payments, exchange and trade controls, and international trade policy determinants. Prerequisites: 64-201, 64-202.

64-404 COMPARATIVE ECONOMIC SYSTEMS **II(3,0)3**
Analysis of free-market and planned economies in theory and practice. Emphasis on the United States and the Soviet Union. Prerequisites: 64-201 or 64-202.

64-405 JAPAN'S ECONOMIC SYSTEM **(3,0)3**
A review of the postwar Japanese Economy and its legacy from the Tokugawa, Meiji and Taisho periods. An analysis of economic and management policies is advanced to explain postwar Japan's high rate of economic growth. The course reviews the fields of labor, finance, management systems, industrial policy, fiscal policy, industrial structure and external economic relations. Prerequisite: 64.202.

64-407 ECONOMETRICS **I(3,0)3**
Review of the basic regression model, violations of the basic assumptions, estimation with deficient data, multiple regression, formulation and estimations of special models, the generalized linear regression model and its applications, and simultaneous equation system. Prerequisite: 64-212 or permission of instructor.

64-408 HISTORY OF ECONOMIC THOUGHT **I(3,0)3**
The rise of classical growth and value theories. The evolution of neoclassical theories of price and distribution, and the development of welfare criteria. A comparison of Keynesian and classical macroeconomic theory. The role of economic analysis of the post-Keynesian world. Prerequisites: 64-303 and 64-304.

64-411 PUBLIC FINANCE **II(3,0)3**
The economics of the public sector. Principles of public expenditure, taxation, and the public debt applied to federal, state, and local governments. Prerequisites: 64-201, 64-202.

64-499 RESEARCH SEMINAR **I,II(3,0)3**
An honors course to permit the advance student to do research in topics of special interest in economics under faculty supervision. This course also may be utilized to offer topics to individual students where there are an insuffi- cient number of registrants for a regular class. Some of the topics which have been offered in the past are mathematics for economists, econometrics, consumer economics, welfare economics and growth theory. Prerequisite: Permission of department chairperson.

DEPARTMENT OF MANAGEMENT

Chairperson: Stuart C. Freedman

Professors: Richard Ducharme, Timm Kainen, Riaz Khan, James Monahan, Santo Pullara, Yash Puri, Joseph Rocha, Louis Yelle

Associate Professors: Russell Boisjoly, Ellen Curtis, Stuart Freedman, Charles Hurst, R. Koundinya, David Lewis, George Liaw, Martin Moser, Rudy Winston

Assistant Professors: Shimon Awerbuch, Bhagwat Jaiman, Pamela Sherer, Joseph Thomas

Instructors: Michael Rouse, Timothy Shea

Visiting Professor: Charles Levenstein

The Department of Management offers a concentration within the Bachelor of Science in Business Administration. In cooperation with the College of Engineering, the department also administers the Bachelor of Science in Industrial Management program.

Management Concentration (Bachelor of Science in Business Administration)

After completion of the freshman-sophomore core subjects, the junior level student concentrating in management must declare a program option which will consist of a minimum of four advanced courses in a particular management discipline. The selection of this option and the courses which comprise it will be made with the assistance of the student's faculty advisor.

COURSE OF STUDY FOR BUSINESS ADMINISTRATION: MANAGEMENT CONCENTRATION

(Bachelor of Science in Business Administration)

Lower Division

Freshman Year

Fall Semester		
42-101	College Writing	3
43- 46-	History or Political Science Elective	3
47-101	General Psychology	3
	Science Elec. (w/lab)	4
92-121	Precalculus	3
39-	Physical Education	0.5
39-	Physical Education	0.5
		17

Spring Semester		
42-101	College Writing II	3
43- 46-	History or Political Science Elective	3
48-101	Sociology	3
	Science Elective	3
92-122	Differential Calculus	3
39-	Physical Education	0.5
39-	Physical Education	0.5
		16

Sophomore Year

Fall Semester		
60-201	Acct. Principles I	3
64-201	Economics I	3
64-211	Statistics I	3
92-201	Integral Calculus	3
	Area II Elective	3
		15

Spring Semester		
42-224	Business Writing	3
60-202	Acct. Principles II	3
64-202	Economics II	3
64-212	Statistics II	3
92-202	Micro Computers and Applications Software	3
		15

The department's six options are described as follows:

Upper Division

Financial Management Option

This option introduces the student to two primary areas of financial management: the responsibilities of the treasurer of the business firm and the financial service functions in institutions such as banks, finance companies, and insurance companies. Students choosing this option are required to take 66-332, Money and Banking; 66-431, Financial Management; 66-432, Financial Institutions and Markets; 66-433, Problems in Finance; 66-434, Investment Management; and 66-438, International Finance.

Junior Year

Fall Semester			Spring Semester		
62-301	Marketing Principles	3	60-311	Managerial Accounting	3
66-331	Business Finance	3	60-362	Business Law	3
66-353	Organizational Behavior	3	64-307	Gov't., Bus. and Society**	3
66-371	Operations Management	3	66-332	Money and Banking	3
	General Elective*	3		Area I, II or III Elec.	3
		15			15

Senior Year

Fall Semester			Spring Semester		
66-431	Financial Management	3		CMS Elective	3
66-432	Financial Inst. and Mkts.	3	66-433	Problems In Finance	3
	Area II Elective	3	66-434	Investment Management	3
	General Elective	3	66-498	Business Policy	3
	General Elective	3	66-438	International Finance	3
		15			15

General Management Option

The general management option provides students with a broad background in all areas of management and related disciplines. Students choosing this concentration are required to take 66-404, Computer Applications to Management; 66-431, Financial Management; 62-303, International Marketing; 66-460, Organizational Theory & Design; 66-473, Operations Analysis Techniques; and one additional College of Management Science elective.

Junior Year

Fall Semester			Spring Semester		
62-301	Marketing Principles	3	60-311	Managerial Accounting	3
66-331	Business Finance	3	60-362	Business Law	3
66-353	Organizational Behavior	3	64-307	Gov't., Bus. and Society**	3
66-371	Operations Management	3	66-404	Computer Applications	3
	General Elective*	3		Area I, II or III Elect.	3
		15			15

Senior Year

Fall Semester			Spring Semester		
66-431	Financial Management	3	62-303	Int'l. Marketing	3
66-473	Operations Analysis	3		CMS Elective	3
	Area II Elective	3	66-460	Org. Theory and Design	3
	General Elective	3	66-498	Business Policy	3
	General Elective	3		General Elective	3
		15			15

* Classes of 1987 and 1988 only; Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

Human Resource Management Option

The human resource management option exposes students to the areas of personnel, industrial relations, and related functions involving the management and development of human resources. Students choosing this area are required to take 66-355, Personnel Management; 66-452, Industrial Relations; plus any four human resources management electives and one international elective. Human resource electives include 66-356, Business Research; 66-356, Orgizational Development; 66-455, Compensation Management; 66-460, Orgization Theory and Design; 66-465, Problems in Human Resources Management; and, 66-468, Special Topics in Human Resources Management.

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	Gov't., Bus. and Society**	3
66-371 Operations Management	3	66-355 Personnel Management	3
General Elective*	3	Area II Elective	3
	15		15

Senior Year

Fall Semester		Spring Semester	
CMS Elective	3	66-498 Business Policy	3
66-452 Industrial Relations	3	66- Human Resources Elect.	3
66- Human Resources Elect.	3	66- Human Resources Elect.	3
General Elective	3	66- Human Resources Elect.	3
General Elective	3	International Elective	3
	15		15

* Classes of 1987 and 1988 only: Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

International Management Option

This option gives the student an understanding of the opportunities and challenges associated with the conduct of business beyond the boundaries of one's own country.

Students in this option are required to take 66-438, International Finance; 62-303, International Marketing; 62-402, International Business; 62-498, Multinational Business Policy; two international management electives, two language electives, and two electives relating to a foreign culture that has geographic congruence with the language studied. International electives include 60-366, International Law; 62-494, Foreign Area Analysis; 64-403, International Trade Theory; 64-404, Comparative Economic Systems; 64-405, Japan's Economic System; 66-403, Comparative Management; and 66-435, International Financial Institutions and Markets.

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	64-307 Gov't., Bus. and Society**	3
66-371 Operations Management	3	66-402 International Business	3
Language Elective I*	3	Language Elective II	3
	15		15

Senior Year

Fall Semester		Spring Semester	
62-303 International Mktg.	3	CMS Elective	3
66-438 International Finance	3	62-498 Multi. Bus. Policy	3
Cultural Elective	3	International Elective	3
General Elective	3	International Elective	3
General Elective*	3	General Elective	3
	15		15

* Classes of 1987 and 1988 only; Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

Management Information Systems Option (for students who will graduate by October, 1988)

This option exposes students to the application of computer-oriented systems techniques and concepts in the context of a wide variety of business problems. Students choosing this option are required to take 66-404, Computer Applicaitons to Management; 66-475, Systems Analysis; 66-477, Information Systems Management; an international management elective; plus one of the following: 66-473, Operations Analysis Techniques; 66-478, Problems in Information Systems; 91-301, Information Systems Design (if taken, credit will not be given for 66-477); 91-302, Information System and Implementation Design (if taken, credit will not be given for 66-477); 92-265, Introduction to PASCAL; 92-365 COBOL Programming I, and 92-461, System Simulation and Modeling.

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	64-307 Gov't., Bus. and Society**	3
66-371 Operations Management	3	66-475 Systems Analysis	3
General Elective	3	Area I, II or III Elect.	3
	15		15

Senior Year

Fall Semester		Spring Semester	
66-404 Computer Applications	3	CMS Elective	3
Area II Elective	3	66-477 Info. Systems Mgt.	3
General Elective	3	66-498 Business Policy	3
General Elective	3	MIS Elective	3
General Elective	3	International Elective	3
	15		15

** 60-365, Law and Society, may be substituted for 64-307.

Management Information Systems Option (effective September 1985 for 1989 graduates, et seq.)

This option exposes students to the application of computer-oriented systems techniques and concepts in the context of a wide variety of business systems. In addition to 92-242, Introduction to Computers, and 66-405, Management Information Systems, which are taken by all students, students choosing this option are required to take 66-407, Systems Analysis and Design, 92-365, COBOL Programming I, 66-473, Operations Analysis Techniques, and 66-476, Data Base Management and Communication; an international management elective; plus any two of the following: 66-406, Decision Support Systems, 66-478, Problems in Information Systems, 92-368, COBOL Programming II, or 92-461, Systems Simulation and Modeling.

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	64-307 Gov't., Bus. and Society**	3
66-371 Operations Management	3	66-475 Systems Analysis and Design	3
66-405 Mgt. Info. Systems	3	Area I, II or III Elect.	3
	15		15

Senior Year

Fall Semester		Spring Semester	
92-365 Cobol Programming	3	66-476 Database/Comm. Mgt.	3
66-473 Operation Analysis	3	66-498 Business Policy	3
International Elective	3	CMS Elective	3
Area II Elective	3	MIS Elective	3
MIS Elective	3	General Elective	3
	15		15

* Classes of 1987 and 1988 only; Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

Operations Management Option

This option introduces the student to managerial responsibilities in production supervision and control, materials management, and production management. Emphasis is placed on productivity improvement, how technological change impinges on the management of operation and A.P.I.C.S. standards. Students choosing this option are required to take 66-372, Operations Planning and Control; 66-473 Operations Analysis Techniques; and 66-474, Cases in Operations Analysis; plus two operations management electives and one international management elective. Operations management electives include 20-476, Statistical Quality Control; 62-404, Physical Distribution Management; 62-406, Purchasing and Materials Management; 66-404, Computer Applications to Management (classes of 1986, 1987, 1988 only); 66-407, Systems Analysis and Design; 66-475, Systems Analysis (classes of 1986, 87, 88 only); 66-477, Information Systems Management (classes of 1986, 87, 88 only).

Junior Year

Fall Semester		Spring Semester	
62-301 Marketing Principles	3	60-311 Managerial Accounting	3
66-331 Business Finance	3	60-362 Business Law	3
66-353 Organizational Behavior	3	64-307 Gov't., Bus. and Society**	3
66-371 Operations Management	3	66-372 Oper. Planning & Control	3
General Elective*	3	Area I, II or III Elect.	3
	15		15

Senior Year

Fall Semester		Spring Semester	
66-473 Operations Analysis Tech.	3	CMS Elective	3
Operations Elective	3	66-474 Cases in Oper. Analysis	3
Area II Elective	3	66-498 Business Policy	3
General Elective	3	General Elective	3
General Elective	3	International Elective	3
	15		15

* Classes of 1987 and 1988 only; Class of 1989 et seq., 66-405, Management Information Systems.

** 60-365, Law and Society, may be substituted for 64-307.

Management (Course Prefix: 66)

66-331 BUSINESS FINANCE I,II(3,0)3
Principles of financial management, including working and fixed capital, sources of funds, financial statements, budgeting and capitalization. Prerequisites: 60-202, 64-201, 64-202.

66-332 MONEY AND BANKING II(3,0)3
Evolution of money and credit and their role in the economy. Monetary policy and the Federal Reserve System. Structure and function of the commercial banking system and the role of other financial institutions. Prerequisites: 64-201, 64-202.

66-353 ORGANIZATIONAL BEHAVIOR I,II(3,0)3
Application of concepts from the behavioral and social sciences to individual and group activity in organizations. Use of behavioral concepts to introduce and implement organizational change.

66-355 PERSONNEL MANAGEMENT II(3,0)3
Recruitment, selection and training of the work force. Wage and salary administration, employee health and safety, welfare and education. Prerequisite: 66-353.

66-356 BUSINESS RESEARCH METHODS II(3,0)3
Examination of various research tools applicable to problems in human resource management and to other management disciplines. Credit not given for students who have taken 66-302. Prerequisites: 66-353 and 64-211.

66-358 ORGANIZATIONAL DEVELOPMENT I(3,0)3
Planned organizational change using the theory and technology of applied behavioral science. Intervention strategies at the individual, group and organizational levels are explored. Prerequisite: 66-353.

66-371 OPERATIONS MANAGEMENT I,II(3,0)3
Principles of production/operations management. Nature and function of production systems; operational planning and control; plant layout; materials handling, inventory and quality control. Prerequisite: 64-211.

66-372 OPERATIONS PLANNING AND CONTROL II(3,0)3
Cases on the application of principles from 66-371 to problems involving continuous, intermittent and job lot production systems for both small and large firms. Prerequisite: 66-371.

66-402 INTERNATIONAL BUSINESS I(3,0)3
Special problems of overseas operations of American firms. Financial, marketing, personnel and legal problems of the multinational enterprise. State trading, economic integration and international regulatory agencies. Prerequisites: 62-301, 64-202.

66-403 COMPARATIVE MANAGEMENT I(3,0)3
Management systems in different national, functional, and institutional settings. The impact of economic, social, political, and cultural variables on management styles. Prerequisites: 64-202, 66-402.

66-404 COMPUTER APPLICATIONS TO MANAGEMENT I(3,0)3
Use of computers as a tool for improving management decisions. Management problems and cases will be analyzed using the University's computer. Prerequisite: 92-242. Note: This course is for graduating classes 1987-1988 only.

66-405 MANAGEMENT INFORMATION SYSTEMS I,II(3,0)3
Structure and foundations of information systems for management from both a users and

designers perspective. Prerequisite: 92-242. This course is required of all business students entering 1985, graduating 1989. Note: This course is an elective for students in the classes of 1987, and '88; it is required for economics, management, marketing and industrial management students in the class of 1989 et seq.

66-406 DECISION SUPPORT SYSTEMS **II(3,0)3**
Study of a class of systems which support the decision process, data retreival and testing of alternatives using languages: spreadsheets, and models. Prerequisite 66-473. NOTE: This course for class of 1989 et seq. only.

66-407 SYSTEMS ANALYSIS AND DESIGN **I(3,0)3**
Study of existing system requirements and design of modifications or a new system. Includes project for actual or hypothetical application. Prerequisite 66-405. NOTE: This course for class of 1989 et seq. only.

66-431 FINANCIAL MANAGEMENT **I(3,0)3**
Advanced study of principles of financial management. Emphasis on case analysis and financial problem solving. Prerequisites: 66-331, 66-332, or permission of instructor.

66-432 FINANCIAL INSTITUTIONS AND MARKETS **II(3,0)3**
Theoretical and pragmatic aspects of the financial process in the economic system. Analysis of financial intermediation. Prerequisites: 66-331, 66-332.

66-433 PROBLEMS IN FINANCE **I,II(3,0)3**
Seminar in special financial topics. Prerequisites: 66-331, 66-332, and permission of instructor.

66-434 INVESTMENT MANAGEMENT **II(3,0)3**
Principles of investment: security analysis, portfolio management, market analysis. Prerequisite: 66-331.

66-435 INTERNATIONAL FINANCIAL INSTITUTIONS AND MARKETS **II(3,0)3**
The financial intermediation function in the international economy. Prerequisite: 66-331.

66-438 INTERNATIONAL FINANCE **II(3,0)3**
Financial aspects of international business operations. Evaluation of risks associated with multinational operation and managerial decision-making under conditions of financial uncertainty. Prerequisite: 66-331.

66-452 INDUSTRIAL RELATIONS **I(3,0)3**
Human interaction and group behavior in organized industrial settings. Union-management relations, grievance procedures, collective bargaining, and arbitration. Prerequisite: 66-353, 66-355.

66-455 COMPENSATION MANAGEMENT **I(3,0)3**
A study of monetary and non-monetary compensation theories and practices in production and service organizations in both public and private sectors. Individual and team research in analyzing and comparing existing compensation systems. Prerequisites: 66-353 and senior standing, or 66-353 and consent of the instructor.

66-460 ORGANIZATION THEORY AND DESIGN **II(3,0)3**
Analyzes organization structures for their effectiveness in various business environments, and examines techniques used by general managers in designing organizations and subunits. Drawing on concepts such as control systems and formalization, the course integrates organizational behavior and business policy by examining individual performance in terms of corporate goals and strategies. Prerequisite: 66-353.

66-465 PROBLEMS IN HUMAN RESOURCE MANAGEMENT **II(3,0)3**
Integration and application of student's skills and knowledge in personnel management, industrial relations and other phases of human resource manage- ment. Individual and team research on selected projects involving both profit-oriented and non-profit enterprises. Prerequisites: Senior standing, 66-452.

66-468 SPECIAL TOPICS IN HUMAN RESOURCE MANAGEMENT **(3,0)3**
Examination of topics of current interest in human resource management. Subject matter to be announced in advance. Prerequisites: 66-353 and junior standing.

66-473 OPERATIONS ANALYSIS TECHNIQUES **I(3,0)3**
Operations research techniques useful in managerial decision making. Mathematical programming, queuing theory, Markov processes and simulation methods. Prerequisites: 66-371, 92-242.

66-474 CASES IN OPERATION ANALYSIS **II(3,0)3**
Application of techniques from operations research to cases in management decision making including scheduling, inventory control and facilities design. Prerequisites: 66-473 or 92-381, 92-242.

66-475 SYSTEMS ANALYSIS **II(3,0)3**
The tools of systems analysis and design. Practical problems in data struc- tures and file management will be run on the University's computer. Prerequisite: 66-404. Note: This course is for the graduating classes 1987-1988 only.

66-476 DATA BASE MANAGEMENT AND COMMUNICATION **I(3,0)3**
A two part course: (1) File organization, data base management schemes, and retreival languages; (2) Network topologies and properties of communication channels. Prerequisite 66-405. Note: This course for class of 1989 et seq. only.

66-477 INFORMATION SYSTEMS MANAGEMENT **II(3,0)3**
Analysis and design of information systems for management planning and control. Prerequisite: 66-475. If taken, credit will not be given for 91-301 or 91-302. Note: This course is for graduating classes 1986-1988 only.

66-478 PROBLEMS IN INFORMATION SYSTEMS **II(3,0)3**
Practice in establishment and evaluation of management information systems. Case analyses from local organizations and business firms.

66-481 RISK MANAGEMENT AND INSURANCE **I(3,0)3**
Analysis of pure risks of economic loss and evaluation of various methods of dealing with risk. Development and implementation of risk management programs for the business firms. Prerequisite: Permission of instructor.

66-495 SMALL BUSINESS PRACTICUM **I,II(3,0)3**
Practical experience in the identification and solution of management problems in smaller businesses in the Merrimack Valley and Greater Boston. Offered in cooperation with U.S. Small Business Administration. Prerequisites: Senior status and permission of program coordinator.

66-497 HONORS PROGRAM SEMINAR **I,II(3,0)3**
Preparation and defense of senior honors thesis in area of concentration. Prerequisite: Permission of Honors Program coordinator.

66-498 BUSINESS POLICY **I,II(3,0)3**
An integration of knowledge in the various functional areas of management toward solu-

tion of problems affecting the character and success of the total enterprise. Corporate strategy and its implementation via appropriate policies. Prerequisite: Graduating senior status.

66-499 RESEARCH SEMINAR **I,II(3,0)3**
An opportunity for the advanced student to perform substantive research in an area for special interest under the supervision of a member of the management faculty. Prerequisite: permission of department chairman. This course may be used as a concentration elective. It may also be used to offer topics to individual students where there are too few registrants for a regular class. Prerequisite: Permission of department chairperson.

FACULTY OF THE COLLEGE OF MANAGEMENT SCIENCE

OFFICE OF THE DEAN

Timm Kainen, B.A., M.A., Ph.D., Acting Dean

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Bong Min Yang, Assistant Professor, Economics; B.S., Seoul National University, Ph.D., Pennsylvania State University

Louis E. Yelle, Professor, Management; B.S., Lowell Technological Institute; M.S., M.B.A., Northeastern University

COLLEGE OF MUSIC

Gerald J. Lloyd, Dean
Erich J. Lear, Assistant Dean

It is the philosophy of the College of Music that every graduate, regardless of area of concentration or personal goal, must be both an educated person and a qualified musician. The study of music involves the development of the intellect, the acquisition of an aesthetic and philosophical comprehension of the art of music, and, in the case of recipients of professional degrees, a high level of proficiency in a chosen discipline in music. The particular degree program which a student may select will depend, of course, upon his or her personal objectives and individual competencies. The Bachelor of Music programs are professional in nature and seek to develop that high degree of musicianship which is fundamental to creative, scholarly and educational practice in music. The Bachelor of Arts program, on the other hand, is appropriate for students with a general interest in music, or with interests in other academic disciplines as well as music.

OBJECTIVES OF THE COLLEGE OF MUSIC

The objectives of the College of Music are to provide each student with the opportunity to master the fundamental knowledge upon which all music is based, to obtain the special and technical knowledge related to one or more of the various branches of music, to develop an understanding and an appreciation of the cultural and social heritage of musical experience, and to appreciate that one's personal education is a lifetime process to be pursued in both formal and informal environments. The faculty of the College of Music believe that each recipient of a baccalaureate degree in music, regardless of personal goal, should be a qualified musician, and it is to this end that all undergraduate programs are directed. Additionally, the program in music education seeks to prepare professional personnel for teaching and leadership positions in a variety of educational levels, to contribute to the development of institutional organizations, arrangements, and service systems concerned with the teaching of music, and to provide leadership in effecting planned change in music programs at all levels of public education.

The programs in sound recording technology and music business are intensive courses of study combining the rigors of music study with those of electrical engineering or business. Each of these latter programs requires an internship semester sponsored by a leading company or organization in the music industry offering the student pragmatic experience in the field.

COLLEGE ORGANIZATION AND GOVERNANCE

The College of Music is organized into three departments and is administered by a dean. Each department is responsible for developing its course offerings and programs of study. and the music faculty, as a whole, is responsible for academic policies. The Academic Standards Committee has oversight of the college's academic standards and serves as a review body for the readmission of suspended students. A Curriculum Committee monitors curricular matters and submits its recommendations to the full faculty for final determination. Specific matters pertaining to subdisciplines in music are referred to the appropriate department and/or faculty.

Curriculum Committee

Dr. Christopher McGahan
Dr. William Moylan
Dr. John Ogasapian
Dr. Rawn Spearman
Dr. Robert White
Dr. Erich Lear, ex officio

Academic Standards Committee

Mrs. Ruth Ashley
Mr. Antone Holevas
Mr. David Martins
Mr. Anthony Mele
Dr. Gerald J. Lloyd, Ex-Officio

Coordinators of Music Areas

Mr. Dean Bouzianis, Theory/Composition
Mr. Fred Buda, Jazz Studies
Mr. David Martins, Woodwinds
Dr. Christopher McGahan, Choral Activities
Dr. William Moylan, Sound Recording Technology
Mr. Ivan Oak, Voice
Dr. John Ogasapian, Music History
Mr. Natalo Paella, Brass
Dr. Kay George Roberts, Strings
Dr. Rawn Spearman, Music Business
Mr. Gary Spellissey, Percussion
Mr. Thomas Stumpf, Keyboard
Mr. Willis Traphagan, Graduate Studies

BACCALAUREATE DEGREE PROGRAMS

The College of Music offers undergraduate programs leading to the degree of Bachelor of Arts and to the professional degree of Bachelor of Music. For details concerning graduate music programs, see the Graduate School Bulletin.

Bachelor of Arts Degree

The purpose of the Bachelor of Arts degree with a major in music is the study of music within the context of a liberal, rather than a professional, education. The Bachelor of Arts degree is intended for the student who has a general interest in music and wishes to secure a broad, comprehensive education or desires to combine his or her music studies with some other major or minor academic field. The requirements for majors are set by university departments but must specify a minimum of 30 semester credits. Although students may not be required to take more than 45 semester credits in the major field, they may elect to take additional courses in the major field beyond the specified required maximum. At least 15 credits in the major field must be taken at the upper division course level. Bachelor of Arts degree programs require a minimum of 75 semester credits outside the major field, except as specified by provisions concerning second majors.

Music majors who are candidates for the Bachelor of Arts degree in the College of Music may elect a second major which is offered by other colleges of the University. Students who elect academic majors in more than one college are candidates for one degree only, and they are considered to be degree candidates in the college of their initial major unless they indicate to the contrary at the time they make a declaration of second major by filing for intercollegiate transfer. Accordingly, a student who pursues a music major in the College of Music and a second major in another college is subject to all degree requirements as specified by the College of Music and is subject only to major course requirements (including any collateral and prerequisite courses for the major) as specified by the department of his or her second major. For a full discussion of University requirements concerning second majors, students should consult the applicable section of this publication which appears under the heading "Academic Policies."

In accordance with the requirements of established minor programs, music majors who matriculate for the degree of Bachelor of Arts may undertake a minor which is offered by another college of the University. Students who are interested in such programs should refer to the appropriate chapters which detail the programs of other colleges.

Music majors who do not desire second majors or minor programs may complete their Bachelor of Arts requirements through a program of elective courses. Such elective programs may not be taken in the College of Music and must be approved by the student's faculty advisor. When presented in fulfillment of collateral degree requirements without a second major or a minor, the program of elective courses must include at least 6 credits of courses which are on or above the 300 course level.

Bachelor of Music Degree

The Bachelor of Music degree is offered in four areas of specialization: music education, music history and literature, theory/composition, and performance. Areas of emphasis of the performance specialization include jazz studies, sound recording technology, and music business. The music education specialization is designed to prepare teachers and supervisors of music in the elementary and secondary schools. The specializations in music history and literature, theory/composition, and performance provide abundant opportunities for individual performance, research, and creativity to students who wish professional careers in music. Programs combining two areas of specialization, e.g., music education/performance, are also available. A student desiring to pursue such a combined course of study must satisfy the requirements in both areas and should plan to spend one or more semesters in residence beyond the normal eight semesters of full-time study which are required for the successful completion of a program with a single area of specialization. Individual and group performances are important aspects of all Bachelor of Music programs, but students in the performance specialization are required to demonstrate outstanding ability as performers in order to satisfy admission and retention standards. Students specializing in music history and literature and in theory/composition must demonstrate similar outstanding abilities in their chosen fields in order to satisfy admission and retention standards. Students preparing for admission to the music education specialization are required to select applied music courses each semester for maintaining and developing their music skills, and they are expected to develop minimum standards of performance in piano and in their areas of performance emphasis. The music education specialization is subject to the same rules and regulations as those which govern all teacher education programs of the University.

All Bachelor of Music candidates must participate in one or more ensembles during each semester of their residence, unless otherwise specified. All Bachelor of Music candidates are expected to reach a level of proficiency in their performance medium which merits faculty permission to perform in public recital.

Music Minor Program for Students Majoring in Liberal Arts

The following two options are available from the College of Music to students in the College of Liberal Arts toward the satisfaction of a minor in music:

Option One—Music Theory/Music History & Literature

6 hours from the following:	6
71-101 Music Theory I	
71-102 Music Theory II	
71-103 Visual/Aural Percep. of Music I	
3 hours from the following:	3
71-161 Music of Western Civilization	
74-261 Survey of Music History I	
74-262 Survey of Music History II	
3 hours from the following:	3
74-133 Development of Jazz	
74-166 Women in Music	
74-200 American Music	
6 hours from the following:	6
74-368 The American Popular Song	
74-463 Music of the Baroque	
74-464 Music of the Classic	
74-465 Music of the Romantic	
74-466 Music of the Twentieth Century	
Total	18

Option Two—Music Theory/Music History & Literature/Performance (Ensembles)

3 hours from the following:	3
71-100 Basic Music Theory	
3 hours from the following:	3
74-161 Music of Western Civilization	
74-261 Survey of Music History I	
74-262 Survey of Music History II	
6 hours from the following:	6
74-368 The American Popular Song	
74-463 Music of the Baroque	
74-464 Music of the Classic	
74-465 Music of the Romantic	
74-466 Music of the Twentieth Century	
6 hours from the following:	6
76-101-253 (Ensembles)	
Total	18

Sound Recording Technology Minor for Students Majoring in Electrical Engineering

This supportive minor in sound recording technology is for electrical engineering majors only. Students are required to apply for admission into the minor sequence of study through a petition filed with the coordinator of sound recording technology. The petition is to be filed after the completion of 71-100,103, and 78-310, and before other related course work.

Requirements

Music Theory	
71-100 Basic Music Theory	3
71-103 Visual and Aural Perception of Music I	3
71-306 Aural Perception of Timbre & Space	3
71-390 Physical Acoustics and Psycho-acoustics	3
Sound Recording Technology	
78-310 Introduction to Recording	3
78-470 Recording Studio Repair & Maintenance	3
One of the following	
78-350 Video Production	3
78-411 Recording Technology II	3
78-450 The Recording Industry	3
Electrical Engineering At least one electrical engineering "technical elective" should be directly applicable to the discipline of sound recording technology	
Total	21

Music History and Literature Minor

Students matriculating for degrees in other colleges of the University and possessing a fundamental knowledge of music may pursue a minor area of study in music history and literature upon the approval of the chairperson of the Department of Academic Studies. A minor area of study in music history and literature consists of 18-24 semester credits as approved by the coordinator, music history. At least 6 credits of the minor must be elected in courses at the 300 level or higher.

GENERAL COLLEGE REQUIREMENTS

In order to qualify for a baccalaureate degree offered by the College of Music, undergraduates must comply with the University core requirements, must conform to the rules of the College of Music which govern degrees and major studies for such degrees, and must earn a 2.00 average in their major concentrations of specializations by the end of the senior year. Additional requirements are specified for retention in specific degree programs.

Students who have failed to achieve a 2.00 average in their major concentrations or specializations by the end of the junior year have not made satisfactory progress toward their degrees, and upon the recommendation of appropriate departmental committees and the concurrence of the Academic Standards Committee of the college, such students may be placed on probationary status in the college or dismissed from the University for inadequate scholarship.

Language Proficiency

The College of Music does not specify a level of language proficiency as a formal requirement for degrees; however, students who anticipate graduate work in such areas as music history and literature are encouraged to develop proficiency during their undergraduate enrollment. Students who desire to present official evidence of language proficiency for purposes of employment or application to graduate school should consult policies listed elsewhere in this publication under the heading "Academic Policies: Language Requirement" for a listing of avenues by which certification of language proficiency may be pursued.

Declaration of Major (BA) or Specialization (BM)

Students enrolled in the College of Music of necessity are committed to pursue one of the established music programs. Admission to major specializations of the Bachelor of Music degree is governed by specific achievement standards which are described under the several specialization headings. In any event, all students are required to file specific declarations of major with the office of the registrar no later than the beginning of their junior year. Students enrolled in other colleges who wish to elect a second major in music which is offered by the college under requirements for the Bachelor of Arts degree must secure the approval of the chairperson of the Department of Academic Studies prior to making such a declaration and must file the appropriate University form with the office of the registrar no later than the end of the freshman year. Students pursuing the Bachelor of Music with emphasis in Sound Recording Technology or Performance should seek admission to the program at the end of the freshman year.

Change of Major

Bachelor of Arts degree candidates in the College of Music may not drop the music major without withdrawing from the University, transferring to another college of the University, or changing their degree program in the College. Students who wish to change their major from music to another major must file for intercollegiate transfer within the University. (Cf. below.) Students who wish to make a change of program from the Bachelor of Arts to the Bachelor of Music degree must secure the approval of the appropriate chairperson. All such changes of program require that the form for declaration of major or change of major be filed with the office of the registrar. Students who are candidates for the Bachelor of Music degree may change their areas of specialization when they have received the permission of the appropriate chairperson.

Transfer Policies

Students transferring to the College of Music from other colleges of the University or from other institutitions may expect recognition of previously completed courses if these are equivalent to those which are specified by curricula of the college. Students who wish to apply for transfer or for intercollegiate transfer to the College of Music are required to achieve satisfactory scores or written tests of musical aptitude and basic music theory which are developed and administered by the College of Music. Students wishing to transfer to Bachelor of Music programs are required to demonstrate their vocal or instrumental ability during an audition before the faculty of the college.

Transfer from other Institutions

Courses which are transferred from other institutions are initially evaluated by the office of admissions in terms of general University requirements. In addition, courses which are presented for transfer are evaluated by professional departments in terms of college and program requirements at the time a student is accepted for matriculation in the College of Music. Courses which are transferred to the University under provisions of the Commonwealth Transfer Compact and which are not creditable to requirements of the College of Music or as unrestricted elective courses will be listed on the student's permanent record card but will not apply to the minimum degree requirements. In the event that a student who has transferred to the University under the Commonwealth Transfer Compact subsequently makes an intercollegiate transfer to the College of Music, all previously completed courses, including transferred courses from the compact institution, will be reevaluated in terms of their applicability to degree requirements of the College of Music.

Repetition of Transferred Courses

A student who has been granted transfer credit, and on that basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be advised to repeat such transferred work at the University or to take a more elementary course than that which has been transferred when the competence of the student has been demonstrably inadequate. Permission to repeat a transferred course is granted by filing an academic petition form with the office of the college dean. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition of the previously transferred course.

Intercollegiate Transfer to the College of Music

Students wishing to transfer from another college of the University must file a petition, together with a transcript of their permanent record cards, with the appropriate department chairperson and the dean of the College of Music by November 1 for spring semester and by April 1 for fall semester transfer. Students are referred to University policies concerning intercollegiate transfer which appear elsewhere in this publication under the heading "Academic Policies: Change of Major with Intercollegiate Transfer" for further procedural details. Records of students who are approved for transfer are reviewed by the office of the dean and, irrespective of grades previously received in other college programs, all courses which may not be applied to college or program requirements are deleted from the student's cumulative grade-point average.

Ordinarily, students may not transfer into programs of the Bachelor of Music degree from other programs of the University; however, such transfer may be permitted for the unusually gifted student early in his or her academic career. Students who make such a transfer may expect to extend their period of study beyond the normal eight semesters.

Applied Music

All Bachelor of Music degree students other than performance specialization students and sound recording technology students must successfully complete eight semesters of applied music on their principal instrument, earning no less than 16 credits toward graduation. An evaluation by a faculty panel is required of all full time undergraduate music students each semester with the exception of the first semester of the freshman year. Studio grades are submitted to the faculty panel prior to the evaluation. In computing the final grade, the faculty evaluation panel may raise or lower the studio grade by a maximum of one full letter grade, or the panel may allow the studio grade to stand as submitted. Any student who, because of an unexcused absence, fails to perform for the faculty panel will receive a final semester grade of F. The performance specialization requires eight semesters of study for a total of 23 credits in applied music. The eighth semester of applied music is waived for Music Business students who enroll for Internship. Sound Recording Technology students take six semesters and 12 hours of applied music.

All Bachelor of Arts, music major students may take up to three semesters and six hours of applied music.

Any student enrolling for applied music beyond the credits required for his or her respective degree and major must do so through the Continuing Education Office. Such enrollment may be either for credit or not for credit but in no case will such credits be applied toward degree requirements.

Panel (Jury) Evaluations

With the exception of freshmen, all undergraduate students play a panel evaluation each semester of residency. First year students play a panel evaluation at the end of the second semester of study.

In the semester that a required recital is performed, the student is exempted from a panel evaluation.

Recital Attendance Requirement

All undergraduate students in the College of Music are required to attend ten concerts and/or recitals each semester from among those listed on the College Performance Calendar. The 2:00 p.m. concert hour on Wednesdays does not fulfill the recital attendance requirement. All undergraduate students in the College of Music are required to attend ALL scheduled 2:00 p.m. concert hours.

Seven semesters of recital attendance are required of each undergraduate student with the following exceptions: (1) Students who are in residence fewer than seven semesters and transfer students must fulfill the recital attendance requirement for each semester they are in residence as a full-time matriculated degree student. (2) Part-time students have no requirement.

Failure to complete the total recital attendance requirement will result in denial of graduation.

Ensemble Requirements

Auditions

All College of Music students are required to audition for an ensemble each semester in which they are full time students.

A student must audition for a two-credit ensemble at the beginning of each semester. If a student does not qualify for a two-credit ensemble, he/she will be assigned to two (2) one-credit ensembles.

Wind, string, brass and percussion majors will audition for an instrumental panel and the keyboard, guitar, and voice majors will audition for a voice and keyboard panel the first week of each semester.

Audition times, dates and rooms will be posted on the ensemble board the first day of each semester.

Participation

Wind, string, brass and percussion players will be assigned to an instrumental ensemble.

Keyboard (piano, organ and accordian) and guitar majors will be assigned to a choral ensemble or to an ensemble that emphasizes their major instrument such as guitar ensemble or mixed chamber ensemble with piano.

Vocal majors will be assigned to a vocal ensemble.

Students, if qualified and by permission of the Department of Performance, may participate in a choral and an instrumental ensemble.

Student Recitals

Students in the performance major or in the jazz studies emphasis are required to present a senior recital, usually while enrolled in Performance Applied VI. In addition, keyboard majors are required to participate in a chamber music recital while enrolled in 76-158 (Piano Ensemble) or 76-159 (Mixed Chamber Ensemble). Students may petition the department chairperson for permission to present the senior recital one semester early, during Performance Applied V. Students in other specializations may also present public recitals. In all cases, students wishing to present a recital must receive recital permission from the applied music instructor, the appropriate applied music coordinator and the chairperson of the Performance Department. A recital permission form may be obtained from the music office and must be submitted no later than November 15 in the fall semester and March 15 in the spring semester.

DEPARTMENT OF ACADEMIC STUDIES

Antone Holevas, Chairperson

Professors: Gerald J. Lloyd, John Ogasapian

Associate Professors: Jacqueline Charette, Alma Espinosa, Paul Gay, Antone Holevas, W. Anne Trenkamp

Assistant Professor: Dean Bouzianis

The Department of Academic Studies offers a specialization in music (Bachelor of Arts degree) and specializations in music history and literature (Bachelor of Music) and music theory/composition (Bachelor of Music).

Music Major (Bachelor of Arts)

Students interested in the Bachelor of Arts program must make formal application to the department chairperson. Students applying to this program should evidence superior academic promise. Applicants are accepted by vote of the faculty of the Department of Academic Studies.

The purpose of the Bachelor of Arts degree with a major in music is the pursuit of musical studies within the context of a liberal, rather than professional, education.

COURSE OF STUDY FOR MUSIC (Bachelor of Arts)

Freshman Year

Fall Semester

71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1 -1	Applied Music I or Ensemble	2
42-101	College Writing I	3
39-	Physical Education	1
	UCR	3
76-	Ensemble**	(2)
		15

Spring Semester

71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1 -2	Applied Music II or Ensemble	2
42-102	College Writing II	3
39-	Physical Education	1
	UCR	3
	UCR	3
76-	Ensemble**	(2)
		18

Sophomore Year

Fall Semester

71-201	Music Theory III	3
72-100	Recital Attendance	0
72-2-2	Applied Music III or Ensemble	2
74-261	Survey of Music History I	3
	UCR	3
	UCR-III (Lab Science)	3-4
76-	Ensemble**	(2)
		14-15

Spring Semester

71-102	Music Theory IV*	3
72-100	Recital Attendance	0
74-262	Survey of Music History II	3
	UCR	3
	UCR	3
	Elective, non-music	3
76-	Ensemble**	(2)
		15

Junior Year

Fall Semester

74-	Music History Electives +	6
72-100	Recital Attendance	0
76-	Ensemble**	(2)
	Elective, non-music	4-3
	Elective Cognates#	6
		16-15

Spring Semester

71-	Music Theory Elective +	3
72-100	Recital Attendance	0
76-	Ensemble**	(2)
	Elective Cognates#	12
		15

* While Music Theory IV satisfies the Standard IV requirement in general education, it is hoped the BA student would explore the area of philosophical values as one cognate area.

** Though all majors in the College of Music are required to take two credits of ensemble each semester, these credits are not credited toward the Bachelor of Arts, music major degree.

# Cognates are groupings of at least three courses around a subject related to a student's major. This method of grouping keeps the student focused on supportive course selection and encourages the planning of the liberal arts courses in relation to the major. Examples of cognates: German, French, Italian, European and American history; etc.

+ The 12 credits of required Music Electives must be selected from the following list:

71-336 Vocal Arranging
71-450 Pedagogy of Theory
71-310 20th Century Theory
71-402 18th Century Counterpoint
71-405 Orchestration
71-407 Electronic Music
74-363 History of Choral Music
74-364 History of Opera
74-365 The Concerto
74-366 The Symphony
74-461 Music of the Middle Ages
74-462 Music of the Renaissance
74-463 Music of the Baroque
74-464 Music of the Classic
74-465 Music of the Romantic
74-466 Twientieth Century Music
74-367 Origins of Jazz
74-368 The American Popular Song

Senior Year

Fall Semester

71-	Music Theory Elective+	3
72-100	Recital Attendance	0
76-	Ensemble**	(2)
	Elective Cognates#	12
		15

Spring Semester

	Seminar	3
76-	Ensemble**	(2)
	Elective Cognates#	12
		15

Total Credits = 122

** Though all majors in the College of Music are required to take two credits of ensemble each semester, these credits are not credited toward the Bachelor of Arts, music major degree.

Cognates are groupings of at least three courses around a subject related to a student's major. This method of grouping keeps the student focused on supportive course selection and encourages the planning of the liberal arts courses in relation to the major. Examples of cognates: German, French, Italian, European and American history; etc.

+ The 12 credits of required Music Electives must be selected from the following list:

71-336 Vocal Arranging
71-450 Pedagogy of Theory
71-310 20th Century Theory
71-402 18th Century Counterpoint
71-405 Orchestration
71-407 Electronic Music
74-363 History of Choral Music
74-364 History of Opera
74-365 The Concerto
74-366 The Symphony
74-461 Music of the Middle Ages
74-462 Music of the Renaissance
74-463 Music of the Baroque
74-464 Music of the Classic
74-465 Music of the Romantic
74-466 Twientieth Century Music
74-367 Origins of Jazz
74-368 The American Popular Song

Music History and Literature (Bachelor of Music)

Students who are interested in the program for Music History and Literature must make formal application to the chairperson of the Department of Academic Studies between December 1 and May 1 of their sophomore year. Students applying to this program should evidence superior promise in the area. Applicants will be accepted by vote of the appropriate department faculty.

Acceptance will be based on the following criteria:

1. An overall 2.5 cumulative average in all courses;
2. A grade of 2.5 in College Writing I and II (42-101,102);
3. A minimum cumulative average of at least 2.5 in freshman and sophomore music theory courses (71-101,102,201) and Visual and Aural Perception of Music (71-103,104,203);
4. A grade of 3.0 or better in Survey of Music History (74-261).

Upon acceptance in the area, the student is required to file a form for declaration of major with the office of the registrar. The appropriate form may be obtained from the registrar and must be returned to this office after the required signatures have been obtained through the chairperson of the Department of Academic Studies.

Students transferring to the college and wishing to specialize in the area of music history and literature must comply with the requirements for admission to this degree program in the College of Music and must satisfy the basic music course requirement, either through lower level courses in the College of Music or through courses taken at another institution of higher learning. Students in music history and literature must complete a thesis during their senior year. The thesis must demonstrate ability to do formal research at a basic level and to organize and present the results of that research in proper form. The thesis is undertaken as a part of 74-496 Projects in Music History, and is directed by a member of the music history faculty.

COURSE OF STUDY FOR MUSIC HISTORY AND LITERATURE (Bachelor of Music)

Freshman Year

Fall Semester		
71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-13	Keyboard Skills I*	2
76-	Ensemble	2
42-101	College Writing I	3
39-	Physical Education	1
		16

Spring Semester		
71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
75-13	Keyboard Skills II*	2
76-	Ensemble	2
42-102	College Writing II	3
39-	Physical Education	1
	UCR	3
		19

Sophomore Year

Fall Semester		
71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2- 1	Applied Music III	2
74-261	Survey of Music History I	3
76-	Ensemble	2
	Music Elective	2
	UCR	3
		18

Spring Semester		
71-204	Visual/Aural Perception of Music IV	3
71-451	Form and Analysis	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
76-	Ensemble	2
	Music Elective	2
	UCR	3
		18

Junior Year

Fall Semester		
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
74-461	Music of the Middle Ages	3
74-462	Music of the Renaissance	3
75-233	Conducting I	2
76-	Ensemble	2
	Music Theory Elective	3
	UCR	3
		18

Spring Semester		
72-100	Recital Attendance	0
72-3- 2	Applied Music VI	2
74-463	Music of the Baroque	3
74-464	Music of the Classic	3
75-234	Conducting II	2
76-	Ensemble	2
	Music Theory Elective	3
	UCR	3
		18

Senior Year

Fall Semester		
72-100	Recital Attendance	0
72-4- 1	Applied Music VII	2
74-465	Music of the Romantic	3
74-495	Directed Study in Music History	3
76-	Ensemble	2
	Music Elective	2
	UCR-Human Values	0-3
	UCR-III (Lab Science)	3-4
		15-19

Spring Semester		
72-4- 2	Applied Music VIII	2
74-466	Music of the 20th Century	3
74-496	Projects in Music History	3
76-	Ensemble	2
	Music Elective	2
	UCR	3
		15

Total Credits = 137 - 144

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

Theory/Composition (Bachelor of Music)

At the time this catalog was sent to the printer, the Theory/Composition specialization was undergoing major revisions. Students interested in completing this program should contact the Chairman of the Department to receive the approved new course description for this program.

Students who are interested in the program for theory/composition must make formal application to the coordinator of music theory, between December 1 and May 1 of their sophomore year. Students applying for admission to this program should evidence superior promise in the area. Acceptance will be predicated on the following criteria: (1) a cumulative average of 3.0 in freshman and sophomore Music Theory (71-101,102,201) and Visual/Aural Perception of Music (71-103,104,203); and (2) a cumulative average of 2.5 in all music courses attempted up to the time of application.

The candidate must request a letter of evaluation from his/her instructors in the areas of music theory and visual/aural perception of music. Instructors will forward such letters to the coordinator of music theory. Applicants will be accepted by vote of the appropriate department faculty.

Students transferring to the college and wishing to specialize in the area of theory/composition must comply with the requirements for admission to the degree program as set forth above and must satisfy the basic music course requirement, either through lower level courses of the College of Music or of another accredited institution of higher education. A student who wishes to emphasize work in the area of composition must present a public performance of at least one instrumental composition of his or her own, lasting six to eight minutes. This composition must be for a chamber ensemble which may or may not include keyboard and/or voice(s). The work should be representative of the candidate's ability to use more than one instrument soloistically. Acceptable media include woodwind quartet, string quartet, mixed groups of instruments, chorus with instrumental accompaniment, or brass or string ensemble. Students must make all necessary arrangements for procuring recital facilities and for rehearsing and conducting their compositions. Arrangements are to be made in consultation with the coordinator of music theory and the student's advisor.

In addition, theory/composition majors must present to the coordinator of music theory by April 25 of their senior year, a portfolio containing the following: (1) a piece for full orchestra, (2) a work for chamber ensemble, and (3) an approved piece in an optional idiom. Among the movements in the pieces submitted there should be (1) a movement in sonata form, and (2) a theme with at least five variations. Acceptance of the portfolio will be by recommendation of the instructor and one other member of the music theory faculty.

Students wishing to emphasize work in the area of pure theory must present to the coordinator of music theory by April 25 of their senior year, a scholarly paper on an approved topic. Acceptance of the paper will be by recommendation of the instructor of 71-414 and one other member of the theory faculty.

COURSE OF STUDY FOR THEORY/COMPOSITION (Bachelor of Music)

Freshman Year

Fall Semester		
71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-1- 3	Keyboard Skills I*	2
76-	Ensemble	2
42-101	College Writing I	3
39-	Physical Education	1
	UCR	3
		19

Spring Semester		
71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
75-1- 3	Keyboard Skills II*	2
76-	Ensemble	2
42-102	College Writing II	3
39-	Physical Education	1
	UCR	3
		19

Sophomore Year

Fall Semester		
71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2- 1	Applied Music III	2
74-261	Survey of Music History I	3
75-233	Conducting I	2
76-	Ensemble	2
	UCR	3
		18

Spring Semester		
71-202	Music Theory IV	3
71-204	Visual/Aural Perception of Music IV	3
71-451	Form and Analysis	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
75-234	Conducting II	2
76-	Ensemble	2
		18

Junior Year

Fall Semester		
71-402	18th Century Counterpoint	3
71-405	Orchestration	3
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
	Music History Elective	3
76-	Ensemble	2
	UCR	3
		16

Spring Semester		Theory	Comp.
72-302	Applied Music VI	2	2
76-	Ensemble	2	2
72-100	Recital Attendance	0	0
71-495	Seminar/Theory D.S.	3	-
	Theory Elective	3	3
	Music Hist. Elective	3	3
71-315	Composition I	-	3
	UCR	3	3
		16	16

Senior Year

Fall Semester		Theory	Comp.
72-4- 1	Applied Music VII	2	2
76-	Ensemble	2	2
72-100	Recital Attendance	0	0
	Theory Elective	3	3
71-415	Composition II	—	3
71-495	Theory D.S.	3	—
	Free Elective	3	3
	UCR	3	3
		16	16

Spring Semester		Theory	Comp.
72-4- 2	Applied Music VIII	2	2
76-	Ensemble	2	2
71-418	Composition III	—	3
71-450	Pedagogy of Theory	3	—
	Free Elective	3	3
	UCR	3	3
		13	13

Total Credits = 135

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

The six credits of free electives may be taken from any of the course offerings within the College of Music (including ensembles) or within any College of the University. These six credits may be earned in two or more area(s) chosen by the student. The Music Theory electives must be selected from 16th Century Counterpoint, Electronic Music, Jazz Arranging, and Seminar in Music Theory. The Music History electives must be selected from the six standard period courses.

Theory/Composition (Course Prefix: 71)

71-100 BASIC MUSIC THEORY

A study of the symbolics of music and their application to the comprehension of the architectural and organizational elements of music literature. Open to non-music majors.
3 cr.

71-101 MUSIC THEORY I

An intensive study of the theoretical language of music. Stresses part writing in S.A.T.B. and basso continuo realization with a free instrumental part which utilizes free voice leading relative to the use of non-harmonic activity and the harmonic principles through first and second inversion triads. Instruments of the string section are covered, and appropriate listening assignments are given. Original composition in the style being studied is required.
3 cr.

71-102 MUSIC THEORY II

A continuation of the practices of Music Theory I relative to part writing both vocal and instrumental including secondary triads, the Neapolitan sixth, modal interchange, dominant sevenths in inversion and root position, modulation, and secondary dominants. Instrumentation covers the woodwind section, and original composition in the style being covered is required. Prerequisite:71-101. 3 cr.

71-103 VISUAL AND AURAL PERCEPTION OF MUSIC I

An introduction to the techniques of translating the symbolics of music into audible sounds, and the reverse. It employs a fixed "do" system and deals with diatonic melodies in major and minor keys, intervals, fundamental beat-patterns, meter and rhythm. Literature from a variety of sources is employed, and harmonic dictation follows the sequence and progress of Music Theory I.
3 cr.

71-104 VISUAL AND AURAL PERCEPTION OF MUSIC II

A continuation of Visual and Aural Perception of Music I requiring greater facility in the skills of perception and execution developed in the previous semester, and the mastery of additional skills required to deal intellectually with notational and musical problems encountered in more sophisticated literature. A variety of clefs, beat subdivisions, artificial divisions, modal and modulating music, jazz and blues idioms as well as an introduction to non-diatonic music literature are included in the course. Harmonic dictation throughout the semester is correlated to Music Theory II. Prerequisite: 71-103. 3 cr.

71-201 MUSIC THEORY III

A continuation of the practices of Music Theory II relative to part writing both vocal and instrumental including remote modulation and satellite keys, the diminished seventh, augmented sixth, ninth, eleventh, and thirteenth extensions, sequential secondary dominants and secondary sevenths. Instrumentation covers the brass section; original work in the style being covered and in various formal configurations is required. Prerequisite: 71-102.
3 cr.

71-202 MUSIC THEORY IV (20th Century)

A study of twentieth century music theory via a compositional approach relative to tertial, quartal, and secundal vertical sonorities, and linear combinations featuring modal and synthetic scale resources as well as serial and preserial atonality. Prerequisite: 71-201.
3 cr.

71-203 VISUAL AND AURAL PERCEPTION OF MUSIC III

An intensive application of requisite skills to chromatic and non-diatonic music, changing and composite meters, displaced accents, cross rhythms, and a vertical approach to reading often necessary in the study of scores. Advanced tonal as well as tonal literature is considered. Harmonic dictation continues to follow the sequence and progress of Music Theory III. Prerequisite: 71-104. 3 cr.

71-204 VISUAL AND AURAL PERCEPTION OF MUSIC IV

A concentration on the techniques employed in solving the notation and musical problems of the music of the 20th century. The considerations include synthetic and non-Western scales, pitch sets and twelve-tone serialism. Prerequisite: 71-203. 3 cr.

71-303 INSTRUMENTAL SOLFEGE

Designed for students who have completed Applied Music IV. Students perform individually for the instructor and class. Details of rhythm, pitch, dynamics, and basic musicianship are corrected and discussed. Prerequisite: 71-204. 3 cr.

71-306 AURAL PERCEPTION OF TIMBRE AND SPACE

The recognition and identification of timbral modifications caused by natural-acoustic phenomena, signal processors, microphone types and techniques, and mixing techniques; culminating with aural analyses of historically significant and state-of-the-art recordings for recording techniques, balance, and imaging. Prerequisite: 71-203. 3 cr.

71-315 COMPOSITION I CLASS

An application of various techniques of musical composition. Class compositions will be performed and critiqued. Prerequisite: 71-201,71-402,71-405. 3 cr.

71-318 KEYBOARD HARMONY

Through realization of continuo, accompaniment of melodies in a pianistic style and facility with a number of chord progressions, keyboard harmony teaches the student, in a musical setting, the basic principles of chord connection. Prerequisite: 71-201. 3 cr.

71-327 JAZZ ARRANGING I

A discussion of the basic concepts of arranging which include approach techniques, melodic analysis, tensions, harmonic progressions, harmonization of melodies, and four part writing. Prerequisite: 71-102. 3 cr.

71-328 JAZZ ARRANGING II

Discussion of tensions, alternate voicings, close and open voicings, characteristics of sectional versus ensemble arranging, writing for four saxes, four brass, and rhythm section. Arrangements will be performed. Prerequisite: 71-327. 3 cr.

71-336 VOCAL ARRANGING

Analysis and practical application of techniques of vocal scoring including women's voices, men's voices, and mixed voices in varied configurations and styles. Prerequisite: 71-201.
3 cr.

71-390 PHYSICAL ACOUSTICS AND PSYCHO-ACOUSTICS

The physical attributes of sound and acoustic measurement; displacement, time, velocity, acceleration, force, energy, resonance, wave shapes and spectral energy distribution are examined for most instruments; acoustic properties of the ear and of enclosed environments; acoustic measurements and instruments. The interrelationships and differences of physical acoustics and psycho-acoustics are stressed. 3 cr.

71-402 EIGHTEENTH CENTURY COUNTERPOINT

An exposition of the contrapuntal practice of the period, as exemplified by the works of J. S. Bach. Specifically, the course deals with the technique of developing independent but complementary melodic lines through the ornamentation of a basic harmonic structure. Representative vocal and instrumental forms are heard and analyzed and the original idiomatic writing is required. Prerequisite: 71-201. 3 cr.

71-405 ORCHESTRATION

A study of orchestral writing for the standard symphony orchestra. Emphasis on advanced instrumentation and on individual scoring projects. Prerequisite: 71-201. 3 cr.

71-407 ELECTRONIC MUSIC

A study of the most recent experiments and techniques in electronic music. Composition and performance using such equipment as the synthesizer and computers. 3 cr.

71-411 SIXTEENTH CENTURY COUNTERPOINT

A study of the contrapuntal practices of the sixteenth century as exemplified by Palestrina and his contemporaries. Representative vocal forms are heard and analyzed, and original composing in the style is required. Prerequisite: 71-201. 3 cr.

71-413 SEMINAR IN MUSIC THEORY

An intense study of advanced topics in music theory. Prerequisite: 71-402,71-405,71-451. 3 cr.

71-414 THEORY RESEARCH PROJECT

Limited to undergraduate theory/composition majors. Individual development of an approved topic under faculty direction. Acceptance of completed work will be by recommendation of the instructor and one other member of the theory faculty. Prerequisite: 71-413. Permission of chairperson required. 3 cr.

71-415 COMPOSITION II

Limited to undergraduate majors in theory/composition. Involves individual composition, composition under the direction of faculty. Prerequisite: 71-315. Permission of chairperson required. 3 cr.

71-418 COMPOSITION III

Continuation of 71-415. Prerequisite: 71-415. Permission of chairperson required. 3 cr.

71-427 JAZZ ARRANGING III

A study of improvisational techniques; writing for five way sax soli, spreads, and six brass soli voicings will be stressed. Arrangements will be performed. Prerequisite: 71-328. 3 cr.

71-428 JAZZ ARRANGING IV

Utilizing contemporary techniques of professional arrangements. Advanced writing for big band. Arrangements will be performed. Prerequisite: 71-427. 3 cr.

71-450 PEDAGOGY OF THEORY

An examination of the principal points of view relative to tonal theory as expressed by the major theorists of the 20th century. Relative weaknesses and strengths will be examined, and students will be expected to develop their own presentation of specific topics for particular pedagogical situations. Prerequisite: 71-201. 3 cr.

71-451 FORM AND ANALYSIS
A study of the structure and organizational principles of music. Prerequisite: 71-202. 3 cr.

71-495 DIRECTED STUDY IN MUSIC THEORY
Individual work under the supervision of a member of the music theory faculty on a wide variety of topics approved by the instructor and the theory faculty. Permission of chairperson required. 3 cr.

Music History (Course Prefix: 74)

74-101 EUROPEAN MUSICAL CULTURAL: MIDDLE AGES AND RENAISSANCE
Examines, with illustrative examples from several eras and locales, music in the courts and cathedrals of Europe before 1600. No previous musical training is necessary. Emphasis is on the role of music in the cultural, artistic, religious, and intellectual life of the times. Open to non-music majors only. 3 cr.

74-133 DEVELOPMENT OF JAZZ
An introduction to the concepts of jazz improvisation, rhythm, harmony and style. The course traces the development of jazz from the early New Orleans idiom to the avant-garde and "free" music of the 60's. Emphasis is on major jazz performers and their recorded performance. Open to non-music majors only. 3 cr.

74-161 MUSIC OF WESTERN CIVILIZATION
A survey of music from earliest times to the present. Significant forms, styles, composers and aesthetic concepts are examined. Open to non-music majors only. 3 cr.

74-166 WOMEN IN MUSIC
Survey of the role of women in music from ancient times to the present, with primary emphasis on composers of art music in the western tradition. Open to non-music majors only. 3 cr.

74-200 AMERICAN MUSIC
A historical survey of music in the United States from colonial times to the present. Open to non-music majors only. 3 cr.

74-201 MUSICAL LIFE IN AMERICA BEFORE 1900
A study of the American music and musical activity during the 17th, 18th, and 19th centuries. Examples drawn from works for concert hall, theatre, church, and home will be used to illustrate. No prior musical training is necessary; the course focuses on music as a cultural element in American life. Open to non-music majors only. 3 cr.

74-261 SURVEY OF MUSIC HISTORY I
A study of sacred and secular musical forms from pre-Christianity to 1750. 3 cr.

74-262 SURVEY OF MUSIC HISTORY II
A study of musical forms and styles from 1750 to present. 3 cr.

74-363 HISTORY OF CHORAL MUSIC
A study of the stylistic and compositional approaches to choral music from Ockegham to Stravinsky. Prerequisite: 74-261, 74-262. 3 cr.

74-367 ORIGINS OF JAZZ
An intense study of the history of jazz from its origins to the present, covering a wide selection of styles and schools of jazz in various ensemble configurations. 3 cr.

74-368 THE AMERICAN POPULAR SONG

A study of American popular song from 1920 to the present. Emphasis will be placed on such representative composers as Kern, Berlin, Gershwin, Rodgers, Porter, Arlen and such lyricists as Hart, Strayhorn, Dietz and Hammerstein. Examples of songs performed by instrumentalists as well as vocalists will be illustrated by recordings and live performances whenever possible. 3 cr.

74-369 TOPICS IN JAZZ

A study of jazz in a seminar format. Will be offered in a revolving basis and will emphasize the big band, bop, free jazz and fusion styles. 3 cr.

74-459 PERFORMANCE PRACTICE

The course functions as a seminar exploring performance practices of western art music from the middle ages to the present. 3 cr.

74-461 MUSIC OF THE MIDDLE AGES

The theory, notations, forms and styles of music from patristic times to 1400 are examined in depth. Prerequisite: 74-261. 3 cr.

74-462 MUSIC OF THE RENAISSANCE

A study of mass, motet, chanson, madrigal and instrumental music of the fifteenth and sixteenth centuries. Prerequisite: 74-261. 3 cr.

74-463 MUSIC OF THE BAROQUE

A stylistic study of the music of the period from 1600-1750. Prerequisite: 74-262. 3 cr.

74-464 MUSIC OF THE CLASSIC

A study of the solo, chamber, symphonic and operatic literature from 1720-1820. Prerequisite: 74-262. 3 cr.

74-465 MUSIC OF THE ROMANTIC

A study of instrumental and vocal forms and styles from 1820 to 1900. Prerequisite: 74-262. 3 cr.

74-466 MUSIC OF THE TWENTIETH CENTURY

An examination of the stylistic trends of music from late Romanticism through current experimental forms. Emphasis on listening and analysis, as well as musicological commentary. Prerequisite: 74-262. 3 cr.

74-495 DIRECTED STUDY IN MUSIC HISTORY

Individual work under the supervision of a member of the music history faculty. May be repeated with permission of the chairperson. 3 cr.

74-496 PROJECTS IN MUSIC HISTORY

Required as a senior project for students in music history and literature concentration. 3 cr.

74-499 SEMINAR

Undergraduate seminar is designed to investigate musical topics from a broader perspective than is usually possible in an undergraduate course. While designed for Bachelor of Arts students with their broader education in related areas, the course is also open to other qualified undergraduate students, with permission of the seminar director. 3 cr.

DEPARTMENT OF PERFORMANCE

Anthony Mele, Chairperson

Professors: Natalo Paella, Kay Roberts, Rawn Spearman, Willis Traphagan

Associate Professors: Erich Lear, Anthony Mele, Ivan Oak

Assistant Professors: David Martins, Christopher McGahan, William Moylan, Thomas Stumpf

The Department of Performance offers the Bachelor of Music degree with programs in Performance, Jazz Studies, Sound Recording Technology, and Music Business.

Performance (Bachelor of Music)

Students wishing to pursue the specialization in performance may apply to the chairperson of the Department of Performance, and are subject to the following requirements:

Application for performance specialization:

1. Admission is limited to upperclasspersons; application is usually made at the end of the first year;
2. Application forms are available at the College of Music office and must be submitted to the Department of Performance Chairperson no later than December 1 for fall auditions, May 1 for spring auditions, and August 15 for summer auditions;
3. Written recommendations from the applied instructor and the appropriate applied coordinator must be submitted to the Chairperson of the Department of Performance by December 6 for fall, May 6, for spring, and August 21 for summer auditions.

Admission requirements:

1. A minimum grade of B is required for each ensemble and applied course.
2. A gradepoint average of 2.0 must be maintained in all music courses.
3. A minimum of thirty music credits are required and must include credit for the following courses:
   a. Applied Music—72-1-1,1-2;
   b. Keyboard Skills—75-131,132 (non-keyboard majors) or 75-133,134 (keyboard majors);
   c. Music Theory (71-101,102); and Visual and Aural Perception of Music (71-103,104);
   d. Ensemble: 2 semesters.
4. A successful audition is required, for which repertoire is developed in consultation with the appropriate applied coordinator.

Retention in performance specialization:

1. A minimum grade of B is required for each ensemble and performance specialization course.
2. A gradepoint average of 2.5 must be maintained for all music courses.
3. Continued full-time enrollment in the prescribed curriculum is required.
4. Recitals are required after the completion of basic music courses:
   a. A senior recital is required during the same semester in which the applied music sequence is completed;

b. Keyboard majors must also participate in a chamber music recital which normally occurs while enrolled in 76-158 or 76-159.

5. Performance in the College of Music recital hour is required during each semester of residency.

Appeals Procedure

Students whose enrollments are terminated in the performance specialization may submit written petitions to the committee of applied music coordinators requesting readmission to the program. All decisions of the committee in evaluating such petitions are final.

Summary of Degree Requirements for Performance

		Credits
1. University Core Requirements		**29-33**
2. Basic Music Courses		**38**
Music Theory/Aural Visual Perception	24	
Survey of Music History	6	
Keyboard Skills	4	
Conducting	4	
3. Applied Music (Including recital)		**23**
4. Ensembles		**20**
Major	16	
Chamber	4	
5. Music Electives (three 3-credit upper level electives)		**9**
6. Performance Courses		**12**
Performance Seminar I	3	
Performance Seminar II	3	
A minimum of three (3) courses from the following list of performance electives:		
Keyboard Pedagogy	2	
Keyboard App. to Study	2	
Applied Keyboard Repitoire	2	
Jazz Keyboard I or II	2	
Vocal Pedagogy	2	
Diction for the Singer	2	
Solo Song Rep. & Performance	2	
Practical Tuning	2	
Practical Intonation	2	
Orchestral Rep. for Winds & Percussion	2	
Contemporary Rep. & Performance Techniques	2	
Techniques for Performance Preparation	2	
Instrumental Solfege	2	
Conducting III	2	
Total Credits		**131-135**

COURSE OF STUDY FOR PERFORMANCE (Bachelor of Music)

Freshman Year

Fall Semester			Spring Semester		
71-101	Music Theory I	3	71-102	Music Theory II	3
71-103	Visual/Aural Perception of Music I	3	71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0	72-100	Recital Attendance	0
72-1- 1	Applied Music I	2	72-1- 2	Applied Music II	2
75-13-	Keyboard Skills I*	2	75-13-	Keyboard Skills II*	2
76-	Ensemble	2	76-	Ensemble	2
42-101	College Writing I	3	42-102	College Writing II	3
	UCR	3		UCR	3
39-	Physical Education	1	39-	Physical Education	1
		19			19

Sophomore Year

Fall Semester			Spring Semester		
71-201	Music Theory III	3	71-202	Music Theory IV	3
71-203	Visual/Aural Perception of Music III	3	71-204	Visual/Aural Perception of Music IV	3
72-100	Recital Attendance	0	72-100	Recital Attendance	0
72-2- 1	Performance Applied I	3	72-2- 2	Performance Applied II	3
74-261	Survey of Music History I	3	74-262	Survey of Music History II	3
75-233	Conducting I	2	75-234	Conducting II	2
75-	Performance Elective	2	75-	Performance Elective	2
76-	Ensemble	2	76-	Ensemble	2
		18			18

Junior Year

Fall Semester			Spring Semester		
	Music Elective	3		Music Elective	3
72-100	Recital Attendance	0	72-100	Recital Attendance	0
72-3-1	Performance Applied III	3	72-3-2	Performance Applied IV	3
75-393	Performance Seminar I	3	75-394	Performance Seminar II	3
76-	Ensemble	2	76-	Ensemble	2
76-	Chamber Ensemble	1	76-	Chamber Ensemble	1
	UCR	3		UCR (Lab Science)	3-4
	UCR (Human Values)	0-3			
		15-18			15-16

Senior Year

Fall Semester			Spring Semester		
	Music Elective	3	72-4-2	Performance Applied VI**	4
72-100	Recital Attendance	0	75-	Performance Elective	2
72-4-1	Performance Applied V	3	76-	Ensemble	1
76-	Ensemble	2	76-	Chamber Ensemble	2
76-	Chamber Ensemble	1		UCR	3
	UCR	3			
	UCR	3			
		15			12

Total Credits = 131 - 135

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

** Recital Semester.

Emphasis in Jazz Studies

Students wishing to elect the jazz studies option in performance may apply to the Coordinator of Jazz Studies subject to the following requirements:

Application for Jazz Studies Option in Performance

1. Applications are usually submitted at the end of the freshman year;
2. Application forms are available at the music office and must be submitted to the coordinator of jazz studies no later than December 1 for fall. May 1 for spring and August 15 for summer;
3. Written recommendations from the applied instructor and the appropriate applied coordinator must be submitted to the coordinator of jazz studies by December 6 for fall, May 6 for spring and August 21 for summer.

Admissions requirements

1. A minimum grade of B for each ensemble and applied course:
2. Satisfactory grades are required in all music courses;
3. A minimum of thirty music credits are required and must include credit for the following courses:
    a. Applied Music—72-1,1-2;
    b. Keyboard Skills—74-131,132 (non-keyboard majors) or 75-133,134 (keyboard majors);
    c. Music Theory 71-101,102; Visual and Aural Perception of Music 71-103,104;
4. A successful audition is required, for which repertoire is developed in consultation with the appropriate applied coordinator and the applied instructor.

Retention in jazz option

1. A minimum grade of B is required in all jazz studies courses and related ensembles:
2. Continued full-time enrollment in the prescribed curriculum is required:
3. Participation in ensembles for each semester of residency is required.

Summary of Degree Requirements

1. University Core Requirements		**29-33**
2. Basic Music Courses		**37**
Music Theory	12	
Aural and Visual Perception	12	
Survey of Musical History	6	
Keyboard Skills	4	
Introduction to Recording	3	
3. Applied Music (Including recital)		**18**
4. Ensembles		**16**
5. Music Electives		**8**
6. Jazz Courses		**25**

Jazz Arranging I and II	6
Jazz Improvisation I and II	6
Origins of Jazz	3
Jazz Keyboard I and II	4
Jazz Electives—selected from: Jazz Arranging III and IV The American Popular Song Topics in Jazz Stage Band Practices	6
Total Credits	**133-137**

COURSE OF STUDY FOR PERFORMANCE: JAZZ STUDIES EMPHASIS (Bachelor of Music)

Freshman Year

Fall Semester

71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-13-	Keyboard Skills I*	2
76-	Ensemble	2
42-101	College Writing I	3
	UCR	3
39-	Physical Education	1
		19

Spring Semester

71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
75-13-	Keyboard Skills II*	2
76-	Ensemble	2
42-102	College Writing II	3
	UCR	3
39-	Physical Education	1
		19

Sophomore Year

Fall Semester

71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2- 1	Applied Music III	2
74-261	Survey of Music History I	3
75-265	Jazz Keyboard I	2
76-	Ensemble	2
	Jazz Elective	3
		18

Spring Semester

71-202	Music Theory IV	3
71-204	Visual/Aural Perception of Music IV	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
75-266	Jazz Keyboard II	2
76-	Ensemble	2
	Music Elective	3
		18

Junior Year

Fall Semester

71-327	Jazz Arranging I	3
71-367	Origins of Jazz	3
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
75-361	Jazz Improvisation I	3
76-	Ensemble	2
	Music Elective	2
	UCR (Human Values)	0-3
		15-18

Spring Semester

71-328	Jazz Arranging II	3
72-100	Recital Attendance	0
72-3- 2	Applied Music VI	2
75-362	Jazz Improvisation II	3
76-	Ensemble	2
	UCR (Lab Science)	3-4
	UCR	3
		16-17

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

Senior Year

Fall Semester		
72-100	Recital Attendance	0
72-493	Perf. Applied Music	3
76-	Ensemble	2
78-310	Introduction to Recording	3
	UCR	3
	UCR	3
		14

Spring Semester		
72-494	Perf. Applied Music, Recital	3
76-	Ensemble	2
	Jazz Elective	3
	Music Elective	3
	UCR	3
		14

Total Credits = 133 - 137

Emphasis in Sound Recording Technology

Though prospective Sound Recording Technology students take some specific courses for their specialization in the freshman year, retention in the program requires an application to the program coordinator prior to the sophomore year.

Admission Requirements:

1. Grade point average of 2.50 or higher in first-year music courses;
2. A successful audition in the student's major performance medium;
3. Demonstrated readiness to undertake the calculus "B" sequence (satisfactory completion of 92-121 Precalculus Mathematics and 92-115 College Trigonometry courses or passing grades on the corresponding mathematics department qualifying examinations or passing grades on the appropriate CLEP Tests).

Requirements for retention and graduation in the Sound Recording Technology program:

1 Satisfactory grades in all music and recording technology courses and in required mathematics, physics, and electrical engineering courses;
2. Satisfactory grade-point average in courses as prescribed by the program coordinator;
3. Continued full-time enrollment in the prescribed curriculum;
4. Participation in ensembles for each semester of residency.

COURSE OF STUDY FOR PERFORMANCE: SOUND RECORDING TECHNOLOGY EMPHASIS

(Bachelor of Music)

Freshman Year

Fall Semester		
71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-13-	Keyboard Skills I*	2
76-	Ensemble	1
42-101	College Writing I	3
92-121	Precalculus Math	3
		17

Spring Semester		
71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
76-	Ensemble	1
42-102	College Writing II	3
92-115	College Trigonometry	3
39-	Physical Education (2)	2
		17

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

Sophomore Year

Fall Semester

71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2-1	Applied Music III	2
74-261	Survey of Music History I	3
76-	Ensemble	1
92-131	Calculus B-1	4
		16

Spring Semester

71-202	Music Theory IV	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
76-	Ensemble	1
78-310	Introduction to Recording	3
92-132	Calculus B-II	4
95-151	Elements of Physics	4
		20

Junior Year

Fall Semester

71-306	Aural Perception of Timbre and Space	3
71-390	Physical Acoustics and Psychoacoustics	3
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
75-334	Conducting for SRT	3
76-	Ensemble	1
78-410	Recording Technology I	3
	Advanced Music Elective	3
		18

Spring Semester

72-100	Recital Attendance	0
72-3- 2	Applied Music VI	2
76-	Ensemble	1
78-350	Video Production	3
78-411	Recording Technology II	3
	Advanced Music Elective	3
16-211	Fundamentals of Electricity and Electronics	3
92-265	Introduction to PASCAL	3
		18

Senior Year

Fall Semester

72-100	Recital Attendance	0
64-201	Economics	3
76-	Ensemble	1
78-450	The Recording Industry	3
78-470	Recording Studio Repair and Maintenance	3
	UCR	3
	UCR	3
	UCR(Lab Science)	3-4
		16-17

Spring Semester

76-	Ensemble	1
78-493	Recording Technology Internship	6
	or	
78-494	Recording Technology Senior Project	
	UCR(Human Values)	0-3
	UCR	3
	UCR	3
		13-16

Total Credits = 135 - 139

Emphasis in Music Business

The music and business program is designed to prepare qualified music students for a number of music related opportunities. The curriculum is made flexible to fit the interests of the students, combining a careful selection of business courses with the music curriculum. The emphasis in music business provides an essential background for the variety of careers available in the music industry. The curriculum includes carefully selected courses in music and business to prepare graduates for careers which offer the greatest opportunities in the music industry. Students must maintain a minimum 2.50 grade point in music and professional business courses to qualify for graduation.

COURSE OF STUDY FOR PERFORMANCE: MUSIC AND BUSINESS EMPHASIS (Bachelor of Music)

Freshman Year

Fall Semester		
71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-1- 3	Keyboard Skills I*	2
76-	Ensemble	2
42-101	College Writing I	3
92-101	Pre Calculus Math	3
39-	Physical Education	1
		19

Spring Semester		
71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
75-1- 3	Keyboard Skills II*	2
76-	Ensemble	2
42-102	College Writing II	3
92-209	Intro Computer BASIC**	3
39-	Physical Education	1
		19

Sophomore Year

Fall Semester		
71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2- 1	Applied Music III	2
74-261	Survey of Music History I	3
75-233	Conducting I	2
76-	Ensemble	2
66-201	Princ. of Accounting I	3
		18

Spring Semester		
71-202	Music Theory IV	3
71-204	Visual/Aural Perception of Music IV	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
75-234	Conducting II	2
76-	Ensemble	2
66-202	Princ. of Accounting II	3
		18

Junior Year

Fall Semester		
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
76-	Ensemble	2
77-301	Basic Fund. of Music Business	3
	Upper Level Music Elec. +	3
64-201	Economics I	3
59-208	Western Cultural Heritage I or	3
59-209	Western Cultural Heritage II	3
		16

Spring Semester		
72-100	Recital Attendance	0
72-3- 2	Applied Music VI	2
76-	Ensemble	2
77-302	Survey of Music Industry	3
	Upper Level Music Elec. +	3
64-202	Economics II	3
77-303	Copyright Law and the Arts	3
		16

* Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

** Recital Semester

+ Recommended upper level music courses

71-327,8	Jazz Arranging I and II
71-336	Vocal Arranging
71-405	Orchestration
71-408	Composition I
74-367	Origins of Jazz
78-410	Introduction to Recording
74-466	20th Century Music

Senior Year

Fall Semester	
72-100 Recital Attendance	0
72-4- 1 Applied Music VII	2
76- Ensemble	2
77-401 Seminar in Music Industry	3
UCR Lab Science	3-4
59-203 Technology & Human Values	3
Upper Level Management Elective***	3
	16-17

Spring Semester	
77-402 Apprenticeship	12
In lieu of apprenticeship, four additional music/business courses may be taken with permission of coordinator and chairperson.	
	12

Total Credits = 134 - 135

*** Recommended upper level management courses

66-321 Marketing Principles
66-325 Marketing Communications
66-326 Business Finance
66-353 Organizational Behavior

Applied Music (Course Prefix: 72)

72-101-402 APPLIED KEYBOARD I-VIII
Studio instruction in graduation sequence on keyboard as the principal instrument.
2 cr.

72-111-412 APPLIED VOICE I-VIII
Studio instruction in graduation sequence on voice as the principal instrument.
2 cr.

72-121-421 APPLIED WOODWINDS I-VIII
Studio instruction in graduation sequence on woodwind as the principal instrument.
2 cr.

72-131-431 APPLIED BRASS AND PERCUSSION I-VIII
Studio instruction in graduation sequence on brass or percussion as the principal instrument.
2 cr.

72-141-441 APPLIED STRINGS I-VIII
Studio instruction in graduation sequence on string as the principal instrument. 2 cr.

72-251-451 PERFORMANCE KEYBOARD I-VI
Studio instruction in graduation sequence on keyboard as the principal instrument for performance majors.
3 cr.
(VI carries 4 cr.)

72-261-461 PERFORMANCE VOICE I-VI
Studio instruction in graduation sequence on voice as the principal instrument for performance majors.
3 cr.
(VI carries 4 cr.)

72-271-471 PERFORMANCE WOODWINDS I-VI
Studio instruction in graduation sequence on woodwind as the principal instrument for performance majors.
3 cr.
(VI carries 4 cr.)

72-281-481 PERFORMANCE BRASS AND PERCUSSION I-VI
Studio instruction in graduation sequence on brass or percussion as the principal instrument for performance majors. 3 cr.
(VI carries 4 cr.)

72-291-491 PERFORMANCE STRINGS I-VI
Studio instruction in graduation sequence on string as the principal instrument for performance majors. 3 cr.
(VI carries 4 cr.)

Performance (Course Prefix: 75)

75-106 CLASS PIANO
Basic introduction to the piano for non-music majors. Open to all students without prerequisite. 3 cr.

75-131 INTRODUCTION TO KEYBOARD I
The emphasis is placed on such keyboard skills as the playing of scales, basic chord progressions, harmonization of melodies, accompaniment patterns, basic solo literature and development of keyboard reading necessary to a working knowledge of the keyboard. 2 cr.

75-132 INTRODUCTION TO KEYBOARD II
A study of more advanced chord progressions, ensemble keyboard playing, patriotic songs, more advanced accompaniment patterns and advanced solo literature. Prerequisite: 75-131. 2 cr.

75-133 KEYBOARD ACCOMPANYING I
A study of accompanying techniques as they apply to the literature for voice and instruments with piano accompaniment. In-class performance and accompanying for panels and recitals. 2 cr.

75-134 KEYBOARD ACCOMPANYING II
A continuation of 75-133 utilizing more advanced literature and further discussions of accompanying techniques. In-class performances and accompanying for panels and recitals. 2 cr.

75-233 CONDUCTING I
Training in basic baton technique and related study for instrumental and choral conducting. 2 cr.

75-234 CONDUCTING II
Continuation of 75-233 exploring more advanced choral and instrumental conducting techniques. 2 cr.

75-253 KEYBOARD PEDAGOGY
Emphasis on studio teaching of beginning, intermediate and early advanced students. Aspects of establishing and maintaining a studio (business aspects, tax, equipment, bookeeping, etc.). Survey of literature for teaching purposes; ways of approaching various concepts, such as reading notes, rhythmic understanding, dynamics, etc. 2 cr.

75-254 KEYBOARD APPROACHES TO STUDY
Examines various possible ways of learning music and preparing for performance. Covers aspects of practice, facets of memorization and the development of habits which lead to keyboard security. 2 cr.

75-265 JAZZ KEYBOARD I
A study of chord progressions, blues scales, chord voicings and melodic harmonization. 2 cr.

75-266 JAZZ KEYBOARD II
A continuation of 75-265. Will introduce the use of chord substitutions and extensions, melodic analysis and the study of various piano styles. Prerequisite: 75-265. 2 cr.

75-333 CONDUCTING III
A continuation of Conducting II (75-234) for advanced students. Permission of instructor required. Prerequisite: 75-234. 2 cr.

75-334 CONDUCTING FOR SRT
This course will provide an intensive study for the SRT student in developing skills in basic conducting and score reading techniques. The emphasis of this course will deal with the development of these skills in diagnosing and correcting ensemble problems and in making informed musical judgements concerning ensemble performance. 3 cr.

75-353 APPLIED KEYBOARD REPERTOIRE
The study and performance of smaller and larger works common to the keyboard repertoire: song form, minuet and trio, prelude, intermezzo, nocturne, impromptu, bagatelle and sonata allegro.
2 cr.

75-361 JAZZ IMPROVISATION I
A study of basic jazz structures, motives, chord progressions, scales, melodic analysis, use of some approach techniques, tensions and their application to the jazz style. Includes in-class performance by small instrumental and/or vocal groups. 3 cr.

75-362 JAZZ IMPROVISATION II
A continuation of 75-361. Will emphasize the study and performance of more advanced levels of improvisation. Prerequisite: 75-361. 3 cr.

75-363 STAGE BAND PRACTICES
A study of instrumental techniques, interpretation of rythmic and melodic figures as they apply to the stage band. In-class performances of representative jazz arrangements will be included. 3 cr.

75-373 PRACTICAL TUNING
The study of orchestral and band instruments relative to tuning. An analysis of the various individual and technical adjustments necessary to arrive at tuning unanimity and the development of a rudimentary concept of pitch and the practical application of these principles to each individual instrument. 2 cr.

75-374 PRACTICAL INTONATION
The study of orchestral and band instruments relative to intonation. The development of conceptual awareness relative to the various characteristics of pitch, which are inherent in the design of the various instruments. Identification of problematic intonation and procedures to alleviate problems through performance. 2 cr.

75-383 ORCHESTRAL REPERTOIRE FOR WINDS AND PERCUSSION
The course is designed as a repertoire reading session dealing with the standard literature of the symphony orchestra, with emphasis on the larger works that are heavily scored for winds. The majority of class time will be devoted to a study of articulation, style, intonation and phrasing as these aspects of the music under consideration relate specifically to the wind instruments. 2 cr.

75-384 CONTEMPORARY REPERTOIRE AND PERFORMANCE TECHNIQUES

A course designed to acquaint the student with various techniques and specialized notational practices from the contemporary repertoire, through actual rehearsals, demonstrations and possible student performances. Representative composers include, Berio, Crumb, Ives, Penderecki and Stravinsky. Open to non-performance majors with permission of the instructor. 2 cr.

75-394 PERFORMANCE SEMINAR I

The study and performance of selected works from the repertoire of each of the five primary areas of performance; keyboard, voice, woodwinds, strings and brass/percussion. Emphasis will be placed on student and faculty performance, leading to detailed consideration of the relationship between the demands of the composer and the problems of the performer and the manner in which these concerns influence the musical and artistic judgements necessary to achieve a quality performance. 3 cr.

75-463 VOCAL PEDAGOGY

The study of current techniques in vocal pedagogy, examined through discussion, interviews, observation of studio teaching, demonstrations and outside readings. During the second half of the semester, class members are assigned to teach students who have had little or no vocal training. Class members are expected to do some research work on vocal repertoire for beginners and advanced students. The course is also appropriate for conductors and accompanists. 2 cr.

75-464 DICTION FOR THE SINGER

The course is designed to acquaint the singer, conductor and accompanist with techniques of enunciation in Italian, German and French as related to the English language. Will include a comparison of sung and spoken language. Students will aslo learn the International Phonetic Alphabet, which applies for all languages. Song repertoire assignments and performance exercises will be utilized.

2 cr.

75-465 SOLO SONG REPERTOIRE AND PERFORMANCE

An extensive study and research of solo song literature in German, French, Italian and English from all major periods of history. The class will also focus on various historical backgrounds, styles of important composers and poets from many different nations. Students will learn how to select suitable songs appropriate to the basic physical nature of individual voices, as well as the various stages of vocal and intellectual maturity. The class will be exposed to the concepts of preparing, memorizing, performing, recital program building and stage deportment. Students are expected to perform for the class frequently throughout the semester. 2 cr.

75-493 PERFORMANCE SEMINAR II

This course is designed as a "master class" experience for students in each of the five primary areas of performance; keyboard, voice, woodwinds, strings and brass/percussion, with a separate section for each area wherever possible. Class sessions will consist of student performances of selected literature, followed by critical analysis from faculty and peers. Each section will be supervised by the appropriate area coordinator, and will also involve invited guest performers selected from faculty, applied faculty and other noted artists. Note: 75-394 is not a prerequisite for 75-493. 3 cr.

75-495 DIRECTED STUDY AND RESEARCH IN PERFORMANCE

Permission of chairperson required. 3 cr.

Ensembles (Course Prefix: 76)

76-101 CHAMBER ORCHESTRA
Open to all students by audition. Works from the orchestral repertoire are studied and publicly performed, with additional opportunities for choral and solo accompaniment. 2 cr.

76-102 WIND ORCHESTRA
Open to all students by audition. A wide variety of works for wind and percussion instruments are studied and performed. 2 cr.

76-103 WIND ENSEMBLE
Open to all students by audition. Compositions are selected from a wide repertoire of wind ensemble literature for study and performance. Opportunity for solo performance with wind ensemble accompaniment. 2 cr.

76-105 CONCERT BAND
Open to all students by audition. Selected band repertoire studied and performed. 2 cr.

76-106 MARCHING BAND
Open to all students of the University, without regard for major field of study. The marching band performs at all U Lowell home football games and appears throughout New England at selected band competitions. “Corps style” marching and special musical arrangements are featured. No audition required. 2 cr.

76-107 REPERTORY BAND
Open to all students by audition. Emphasis on reading and rehearsing a wide selection of band literature. Some public performance. 2 cr.

76-108 STUDIO ORCHESTRA
Open to all students by audition. A wide spectrum of jazz orchestration and solo performance is studied and performed. 2 cr.

76-150 INSTRUMENTAL ENSEMBLE
Open to all students by audition. Provides students with a clear understanding of the skills, knowledge and attitudes necessary to satisfactory ensemble performance, and practical experience in the application of such skills, knowledge and attitudes. 2 cr.

76-151 BRASS ENSEMBLE
Open to all students by audition. Provides a wide range of performance experience through varied brass literature. 1 cr.

76-152 STRING ENSEMBLE
Open to all students by audition. Provides experience with string chamber literature. 1 cr.

76-153 PERCUSSION ENSEMBLE
Open to all students by audition. Exploration of the growing body of literature for percussion ensemble. Public performance. 1 cr.

76-155 STRING QUARTET
Open to all students by audition. Study of the best string quartet literature. 1 cr.

76-156 GUITAR ENSEMBLE
Open to all students by audition. Provides study and performance of literature for guitar, lute, etc. Required of all guitar majors each semester. 1 cr.

76-157 WOODWIND QUINTET

Open to all students by audition. Offers study and performance of literature for woodwind quintet. 1 cr.

76-158 PIANO ENSEMBLE

Open to all students by audition. Provides performance experiences through varied piano ensemble literature. 1 cr.

76-159 MIXED CHAMBER ENSEMBLE

Open to all students by audition. Offers a wide range of performance experience through a selection of literature for varying combinations of instruments. 1 cr.

76-160 STRING ENSEMBLE

Open to all students by audition. Provides experience in the performance of string orchestra literature. 1 cr.

76-161 SMALL JAZZ ENSEMBLE

Open to all students by audition. Provides experience in the performance of jazz literature for groups ranging from four to eight members. 1 cr.

76-162 JAZZ LAB ENSEMBLE

Open to all students by audition. Provides students with a clear understanding of the skills, knowledge and attitudes necessary to satisfactory ensemble performance and practical experience in the application of such skills, knowledge and attitudes. 1 cr.

76-163 MALLET ENSEMBLE

Open to all students by audition. The various mallet percussion instruments are used to provide the percussion player an opportunity to experience providing melody and harmony. 1 cr.

76-164 SAXOPHONE QUARTET

Open to all students by audition. Offers study and performance of literature for saxophone quartet. 1 cr.

76-201 CHAMBER SINGERS

A small, select choir open to all singers by audition. Performs music ranging from the present day to the Middle Ages. 2 cr.

76-202 COLLEGIATE CHORALE

Open to all students by audition. Includes the study and performance of a wide variety of choral compositions. 2 cr.

76-203 CONSORTIUM ARTIS MUSICAE

Open to all students by audition. Devoted to the study and performance of a variety of early vocal and instrumental music. 1 cr.

76-204 OPERA STUDIO

Open to all students by audition. Offers experience in the theory and practice of opera performance. Includes preparation of roles, rehearsal techniques, ensemble singing, and operatic traditions. Oak. 1 cr.

76-210 OPERA WORKSHOP

Open to all students. Practical experience in the non-performing aspects of operatic and broadway show production. 1 cr.

76-251 CHORAL UNION

A large chorus open to the campus and the community without audition. Performs larger works in the choral repertoire including oratorios, masses, motets and opera. 1 cr.

76-253 JAZZ SWING CHOIR

Open to all students by audition. Provides opportunity for study and performance of jazz choral literature. 1 cr.

Music Business (Course Prefix: 77)

77-301 FUNDAMENTALS OF MUSIC BUSINESS

A career oriented examination of alternative music careers. Equal focus on the artistic and business aspects of positions in the music industry. Includes local field assignments in the industry, jointly supervised by the music faculty and industry personnel. Visiting professionals from the industry will discuss their background and experience. 3 cr.

77-302 SURVEY OF THE MUSIC INDUSTRY

A systematic look at career options in the music industry, including an examination of the way in which technology and the changing marketplace affect the industry. Includes field experiences in which students visit a number of music industries in Massachusetts and in other states. 3 cr.

77-303 COPYRIGHT LAW AND THE ARTS

Explores the special character of arts related contractual applications: misappropriations, fair use, works made for hire, etc. Provides understanding of copyright terminology. Explores which authors and composers are protected under copyright statute. 3 cr.

77-401 SEMINAR IN THE MUSIC INDUSTRY

The course provides students with an opportunity to meet with industry professionals—performers, managers, and arts administrators—who will discuss their careers and enable students to acquire first hand knowledge of the diverse opportunities in the music industry prior to undertaking the apprenticeship. 3 cr

77-402 APPRENTICESHIP IN THE MUSIC INDUSTRY

Students will be assigned a 15 week internship at a company in the music industry which offers a varied, practical and challenging learning experience. 3 cr.

77-495 DIRECTED STUDIES IN MUSIC BUSINESS

Permission of coordinator required. 3 cr.

Sound Recording Technology (Course Prefix: 78)

78-310 INTRODUCTION TO RECORDING

The theory and usage of audio-recording/reproduction components are explored at a basic level, and supplemented by hands-on experience. The aesthetics of recording media and their influence on society are discussed in relation to the artistic and commercial functions of the media. Individual research on a subject of interest to the student is required. Permission of coordinator required. 3 cr.

78-350 VIDEO PRODUCTION

An introductory course in the fundamentals of video technology and production; encompassing signal transmission, tape formats, transduction, optical characteristics of lenses and cameras, production equipment and procedures, and post-production equipment and techniques; hands-on experience via video and audio for video projects. 3 cr.

78-410 RECORDING TECHNOLOGY I

Audio production. Planning and execution of recording sessions which involve a variety of musical ensembles under diverse recording conditions; live-performance/concert recordings; advanced multitrack recording, overdub, and remix procedures; application of informed musical judgement to the mixing process; research in recording techniques. Prerequisite: 78-310. 3 cr.

78-411 RECORDING TECHNOLOGY II

An in-depth examination of the principles and operating specifications of the major components of the modern recording studio: mastering and multi-track recorders, mixing consoles, microphones, monitoring systems, and signal processing equipment. Recording projects and technical research. Prerequisite: 78-410. 3 cr.

78-420 SOUND SYNTHESIS I

Sound synthesis equipment and techniques are studied and supplemented with sound synthesis studio laboratory work. The course will cover practices and principles of analog and digital sound synthesis and their historic origins, related audio equipment and applications, theories of sound samplers and sequencers, and an introduction to MIDI applications in theories of sound samplers and sequencers, and an introduction to MIDI applications in sound synthesis and recording production. Prerequisite: Junior standing music major, SRT minor. Permission of the chairman. 3 cr.

78-421 SOUND SYNTHESIS II

Advanced sound synthesis techniques are studied, and supplemented with sound synthesis studio laboratory work. The course will cover MIDI implementation in analog and digital sound synthesis, the historic origins of computer music and electro-acoustic music, live electronic music performance, audio equipment and applications of MIDI-based and functional devices and processors, advanced music production and sound synthesis via MIDI. Prerequisite: 78-420,78-430 and permission of the chairman. 3 cr.

78-430 COMPUTER APPLICATIONS IN MUSIC

Applications of computer technology to music are studied, and supplemented with laboratory work. The course will cover musical applications of data searches and analysis, algorithms, high level languages, computer assisted instruction, artificial intelligence, computer generated and controlled sound sources and devices, computer music, digital signal processing, and MIDI. Prerequisite: music major or minor. Others, permission of the chairman; 92-265. No credit for Computer Science majors. 3 cr.

78-450 THE RECORDING INDUSTRY

A detailed survey of the many career options of the audio-recording industry; position duties and responsibilities. Guest lecturers from diverse careers in the industry share their experiences, disciplines, and backgrounds. Prerequisite: 78-310. 3 cr.

78-470 RECORDING STUDIO REPAIR AND MAINTENANCE

Common minor repairs and routine maintenance of recording equipment; test equipment and tools; power supplies, op-amps, and low-noise amplifiers; distortion; analog and digital hardware; interface considerations. Hands-on experience in repair and maintenance techniques. Prerequisite: 78-411. 3 cr.

78-490 SEMINAR IN SOUND RECORDING TECHNOLOGY TECHNICAL RESEARCH

An open forum is created for students to undertake research projects of a technical nature and that are directly related to SRT. The course will require constant class participation through discussion of research findings and techniques on projects related to audio equipment and applications; theories of operation and design, human interfacing considerations, hardware and software development, enhancing creative flexibility in sound synthesis and recording production. Prerequisite: SRT majors or minors. Others, permission of the chairman. 3 cr.

78-493 RECORDING TECHNOLOGY INTERNSHIP
Practical experience in audio-recording under the supervision of a professional firm. At least twenty hours per week for fifteen weeks is spent working at an entry-level position for a firm involved in audio production. Permission of coordinator required. 6 cr.

78-494 RECORDING TECHNOLOGY SENIOR PROJECT
Advanced projects developed in consultation with faculty advisor. Typical projects include production of a complete record album, investigation of experimental recording techniques, and original research in recording technology. To be elected in place of 78-493 by students not choosing an internship. Permission of coordinator required. 6 cr.

78-495 DIRECTED STUDY IN SOUND RECORDING TECHNOLOGY
Individual work under the supervision of a member of the SRT faculty on a topic or area of production approved by the instructor and the coordinator of SRT. Permission of coordinator required. 3 cr.

DEPARTMENT OF MUSIC EDUCATION

Ruth Ashley, Chairperson

Professors: Donald Bravo, Paul Gayzagian

Associate Professor: Ruth Ashley, Robert White

The department of Music Education offers a specialization in Music Education.

Music Education (Bachelor of Music)

Admission Requirements

1. Though prospective Music Education students take some specific courses for their specialization in the freshman and sophomore years, retention in the program requires an application to the Chairperson of Music Education prior to the junior year;
2. Prospective music education students must pass courses in music including Music Theory, Visual/Aural Perception of Music, Conducting, Music History, Applied Music, Ensembles;
3. Prospective music education students must pass two semesters of College Writing with a grade of C or better and accumulate a minimum of 60 credits (music and non-music courses);
4. Prospective music education students must achieve a cumulative average of 2.5 or better overall and achieve the same cumulative average in the aggregate of music courses.

Summary of Degree Requirements

1. Intro. to Music Education is a prerequisite for professional courses in music education.
2. All music education students must accumulate credits in both vocal and instrumental ensembles. Each music education major must have a minimum of one semester of choral experience and one semester of instrumental experience. Major ensembles, chamber ensembles, and laboratory ensembles are acceptable.
3. Laboratory experiences may fulfill the requirement above but cannot be included in the basic music ensemble requirement of 16 credits.
4. Laboratory Orchestra is open to vocal and keyboard majors, and to the instrumental major who is not playing his/her major instrument.
5. Prerequisite courses for laboratory ensembles:
   a. Appropriate instumental class.
   b. Conducting I.
6. Marching Band Techniques is offered to all students who have been in Marching Band for one semester.

Music Education Electives

Minimum Requirement

1. Eight credits from Group A.
2. Two credits from Group B.

Group A

Introduction to High Brass	2 credits
Introduction to Low Brass	2 credits
Introduction to Clarinet	2 credits
Introduction to Flute	2 credits
Introduction to Bassoon	2 credits
Introduction to Oboe	2 credits
Introduction to Strings	2 credits
Introduction to Percussion	2 credits
Introduction to Saxophone	2 credits
Class Voice	2 credits
Class Guitar	2 credits

All Music Education Majors are required to take one semester of instrumental class from each family of the orchestra excluding their major instrument.

Group B

Laboratory Chorus*	2 credits
Laboratory Orchestra**	2 credits

* Keyboard and Instrumental Majors only.

** Prerequisite: Appropriate Instrumental Class and Conducting I.

COURSE OF STUDY FOR MUSIC EDUCATION
(Bachelor of Music)

Freshman Year

Fall Semester		
71-101	Music Theory I	3
71-103	Visual/Aural Perception of Music I	3
72-100	Recital Attendance	0
72-1- 1	Applied Music I	2
75-1- 3	Keyboard Skills I+	2
76-	Ensemble	2
42-101	College Writing I	3
47-163	Human Life Span	3
39-	Physical Education	1
		19

Spring Semester		
71-102	Music Theory II	3
71-104	Visual/Aural Perception of Music II	3
72-100	Recital Attendance	0
72-1- 2	Applied Music II	2
75-1- 3	Keyboard Skills II+	2
76-	Ensemble	2
42-102	College Writing II	3
47-262	Adolescent Psychology	3
39-	Physical Education	1
		19

Sophomore Year

Fall Semester		
71-201	Music Theory III	3
71-203	Visual/Aural Perception of Music III	3
72-100	Recital Attendance	0
72-2- 1	Applied Music III	2
74-261	Survey of Music History I	3
75-233	Conducting I	2
76-	Ensemble	2
	UCR	3
		18

Spring Semester		
71-202	Music Theory IV	3
71-204	Visual/Aural Perception of Music IV	3
72-100	Recital Attendance	0
72-2- 2	Applied Music IV	2
74-262	Survey of Music History II	3
75-234	Conducting II	2
76-	Ensemble	2
	UCR	3
		18

Junior Year

Fall Semester		
72-100	Recital Attendance	0
72-3- 1	Applied Music V	2
73-151	Intro to Music Education	2
76-	Ensemble	2
73-	Music Ed. Elective (Group A)*	6
	Music History or Theory***	3
	Upper Level Elective UCR	3
		18

Spring Semester		
72-100	Recital Attendance	0
72-3- 2	Applied Music VI	2
73-370	His/Phil/Prin/Prac/Mus. Ed.	4
76-	Ensemble	2
73-	Music Ed. Elective (Group B)**	2
	Music History or Theory***	3
	Upper Level Elective	
47-261	Child Psychology****	3
	UCR Lab Science	3-4
		16-20

+Introduction to Keyboard I and II for non-keyboard majors.
Keyboard Accompanying I and II for keyboard majors.

* A total of 8 credits are required from Group A electives, with at least one chosen from each family of the orchestra excluding the student's major instrument.

** A total of 2 credits are required from Group B electives.

*** Courses selected from among: 71-303, 71-327, 71-405, 74-462, 74-463, 74-464, 74-465, 74-466. Other courses with the approval of the Chairperson of the Department of Music Education.

**** Required for only K-9 and K-12 certification.

Senior Year

Fall Semester		
72-100	Recital Attendance	0
72-4- 2	Applied Music VII	2
73-392	Music Ed. Methods	4
73-397	Issues in Music Ed.	3
76-	Ensemble	2
	UCR	3
	UCR (Human Values)	0-3
73-	Music Ed. Elec. (Group A)	2
		16-19

Spring Semester		
72-4- 2	Applied Music VIII	2
73-491	Apprentice Teaching (K-9)	(12)
	or	
73-492	Apprentice Teaching (5-12)	(12)
	or	
73-493	Apprentice Teaching (K-9,5-12)	(16)
76-	Ensemble	2
		16-20

Total Credits = 140 - 151

Music Education (Course Prefix: 73)

73-141 INTRODUCTION TO HIGH BRASS

Intensive class instruction in the fundamentals of playing brass instruments. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-142 INTRODUCTION TO LOW BRASS

Intensive class instruction in the fundamentals of playing brass instruments. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-144 INTRODUCTION TO FLUTE

Intensive class instruction in the fundamentals of playing the flute. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-151 INTRODUCTION TO MUSIC EDUCATION

A program designed to acquaint underclassmen with music education principles and practices. Students will observe music education activities in selected public schools. 2 cr.

73-161 MARCHING BAND TECHNIQUES

Instruction in organizing and developing a marching band. Specific philosophies, techniques. and band literature in a realistic setting with the University marching band. 1 cr.

73-162 INTRODUCTION TO PERCUSSION

Intensive class instruction in the fundamentals of playing percussion instruments. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-190 LABORATORY CHORUS

Choral experiences for the non-voice major. Intensive study of public school choral literature; conducting and rehearsal techniques; understanding and developing choral skills. 2 cr.

73-191 LABORATORY ORCHESTRA

Instrumental experiences for students on a secondary instrument. Intensive study of public school orchestra literature: conducting and rehearsal techniques: understanding and developing skills on secondary instruments. 2 cr.

73-236 INTRODUCTION TO BASSOON

Intensive class instruction in the fundamentals of playing the bassoon. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-237 INTRODUCTION TO OBOE

Intensive class instruction in the fundamentals of playing the oboe. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-241 INTRODUCTION TO CLARINET

Intensive class instruction in the fundamentals of playing the clarinet. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-242 INTRODUCTION TO STRINGS

Intensive class instruction in the fundamentals of playing string instruments. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

73-243 CLASS VOICE

This course is intended to cultivate the fundamental principles of singing. The psychology of singing and physiology of the singing voice are considered as they apply to tone production, resonance. This course is designed for non-voice majors. 2 cr.

73-245 CLASS GUITAR

A course designed to enable students to develop skill in playing guitar and acquiring pedagogical principles of teaching guitar in groups. 2 cr.

73-247 INTRODUCTION TO SAXOPHONE

Intensive class instruction in the fundamentals of playing the saxophone. The student is expected to gain skill for beginning teaching and demonstration purposes. 2 cr.

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Examination of the history and different philosophies of music education. Educational and psychological principles and practices in conjunction with field experiences are an integral component of the course. 4 cr.

73-392 MUSIC METHODS

A course designed to prepare students for apprentice teaching in the elementary and secondary schools. Reviews the characteristics and attitudes of adolescence, and explores teacher attitudes as related to success in music teaching. Provides experience with a variety of approaches and activities appropriate to both levels. Observations, demonstrations, and actual teaching in select public school classrooms are integral parts of the course.
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Full-time apprentice teaching of music in public elementary schools under the supervision of qualified classroom teachers, administrators, music specialists, and members of the college faculty. Provides experience for the student in applying contemporary principles and techniques studied in music and music education courses, and in using a wide variety of materials and equipment. Prerequisite: 73-392. 12 cr.

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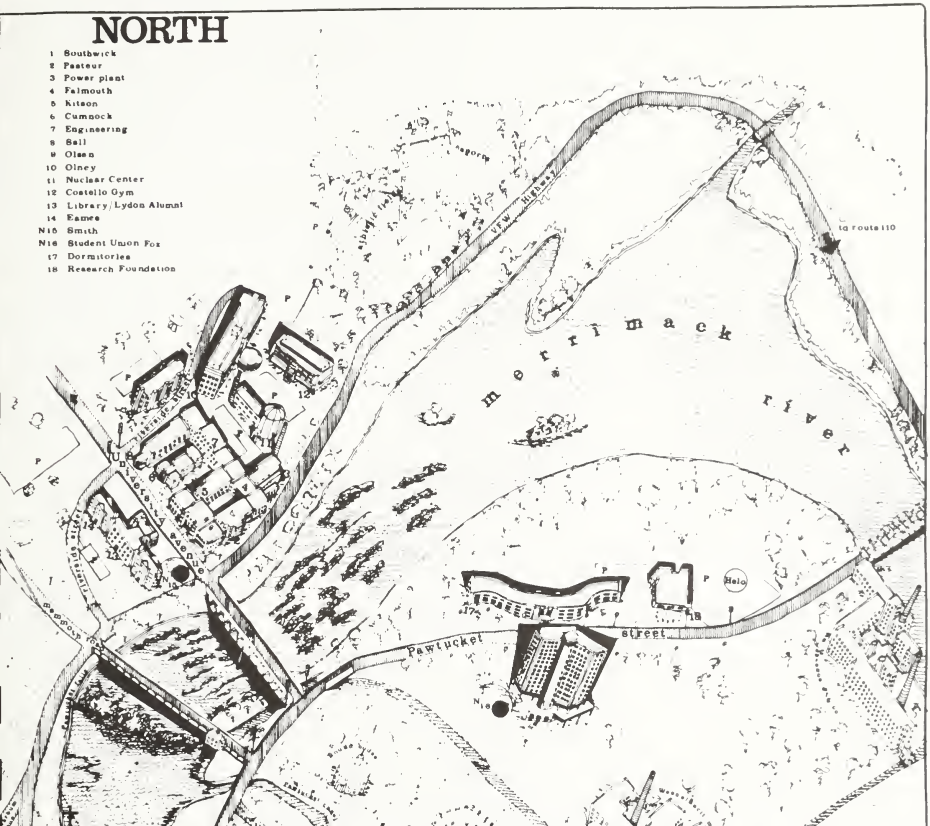

NORTH

1	Southwick
2	Pasteur
3	Power plant
4	Falmouth
5	Kitson
6	Cumnock
7	Engineering
8	Ball
9	Olsen
10	Olney
11	Nuclear Center
12	Costello Gym
13	Library/Lydon Alumni
14	Eames
N15	Smith
N16	Student Union Fox
17	Dormitories
18	Research Foundation

Scale
Distance N15 SMITH to S1
DURGIN Hall approx 1 mile.
S1 to N16 STUDENT UNION
N Fox approx 3/4 mile

SOUTH

S1	Durgin hall
2	Library O'leary hall
3	Student Union
4	Weed hall
5	Concordia hall
6	Allen hall
7	Dugan hall
8	Dining hall
9	Coburn hall
10	Mahoney hall
11	Power plant
P	Parking

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Lowell, MA 01854

Third Class Mail